THE SCANDINAVIAN FANTASY: 
THE SOURCES OF INTER-
GENERATIONAL MOBILITY 
IN DENMARK AND THE U.S. 

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June 12, 2016

*This paper was presented at a Conference on Social Mobility held at the University of Chicago on November 5th, 2014, under the title “The Role of Income and Credit Constraints in Human Development’ Part II.” We thank Linor Kiknadze for very helpful research assistance. We thank Magne Mogstad and the participants in the conference for thoughtful comments. We also received helpful comments at a January 2015 seminar at the Norwegian School of Economics, and seminars at the University of Copenhagen, Aarhus University, SOFI (Stockholm), INET Paris (April 2015), and Copenhagen Education Network. We are especially grateful to Roger Bivand, Sam Bowles, Juanna Joensen, Øivind Anti Nilsen, Kjell Salvanes, Agnar Sandmo, Erik Sørensen, Torben Tranæs, Anders Björklund, and Matthew Lindquist. We have received helpful comments on this draft of the paper from Juanna Schrøter Joensen, Richard Neimand, Matt Tauzer, and Ingvil Gaarder. This research was supported in part by: the Pritzker Children’s Initiative; the Buffett Early Childhood Fund; NIH grants NICHD R37HD065072, NICHD R01HD054702, and NIA R24AG048081; an anonymous funder; The Rockwool Foundation; Successful Pathways from School to Work, an initiative of the University of Chicago’s Committee on Education and funded by the Hymen Milgrom Supporting Organization; the Human Capital and Economic Opportunity Global Working Group, an initiative of the Center for the Economics of Human Development and funded by the Institute for New Economic Thinking; and the American Bar Foundation. The views expressed in this paper are solely those of the authors and do not necessarily represent those of the funders or the official views of the National Institutes of Health. The Web Appendix for this paper is https://heckman.uchicago.edu/mobility_denmark_us.
Abstract

This paper examines the sources of differences in social mobility between the U.S. and Denmark. Measured by income mobility, Denmark is a more mobile society, but not when measured by educational mobility. There are pronounced nonlinearities in income and educational mobility in both countries. Greater Danish income mobility is largely a consequence of redistributional tax, transfer, and wage compression policies. While Danish social policies for children produce more favorable cognitive test scores for disadvantaged children, these do not translate into more favorable educational outcomes, partly because of disincentives to acquire education arising from the redistributional policies that increase income mobility.

Keywords: inequality, education, social mobility, comparative analysis of systems

JEL codes: I32, I28, I24, P51

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1 Introduction

Policy analysts around the world point to Scandinavia as a model for reducing inequality and promoting intergenerational mobility (see, e.g., Baily [2016]). By conventional measures, social mobility by income is much higher there than in the U.S.

This paper uses rich Danish data to explore the sources of these differences in social mobility. By all accounts, Denmark is a prototypical Scandinavian welfare state. Lessons learned from Danish data apply to Scandinavia, more generally.

Our investigation reveals some surprises and apparent contradictions. The literature on Danish social mobility by income is surprisingly sparse and uses only a limited number of measures of income. One contribution of this paper is to demonstrate that the choice of the measure of income used matters greatly in determining the relative social mobility of the U.S. and Denmark.

The standard measure of intergenerational mobility is based on the intergenerational elasticity (IGE): a regression coefficient showing the percentage change in a child’s income associated with a percentage change in parental income. We show that estimated IGEs depend greatly on the measure of income used and that estimated IGEs vary with the level of income. U.S. social mobility is low (absolutely and compared to Denmark) for children from high income families.

Popular discussions of the benefits of the Scandinavian welfare state point to its generous support of child care and education relative to the U.S. as major determinants of its greater social mobility. In Denmark, college tuition is free, there is ready access to child care, pregnancy
leave policy is generous, and there is virtually universal free pre-K. Yet despite these stark policy differences, the influence of family background on educational attainment is surprisingly similar in the two countries. Levels of intergenerational educational mobility are about the same. At higher levels of family income, educational mobility is lower in both countries.

In both countries, cognitive and non-cognitive skills acquired by age 15 are more important for predicting educational attainment than parental income. The more child-generous Danish welfare state produces much more favorable distribution of cognitive skills for disadvantaged Danish children compared to their counterparts in the U.S. The similarity of the influence of family background on educational attainment in the two countries, despite the most favorable distribution of test scores for Danish disadvantaged children, arises in part from the compression of the wage scale and the generous levels of social benefits that discourage Danish children from pursuing further schooling. In addition, the generosity of the Danish welfare state does not prevent sorting of children into neighborhoods and schools on the basis of family background, which appears to benefit the more advantaged.

Scandinavia invests heavily in child development and boosts the test scores of the disadvantaged. It then undoes these beneficial effects by providing weak labor market incentives. Better incentives to acquire skills would boost Danish educational mobility. Stated differently, the greater incentives to acquire education in the U.S. labor market tend to offset its less favorable investments in the cognitive skills of disadvantaged children. In addition, while the Danish welfare state promotes equality of opportunity compared to the U.S., many barriers remain. There are large skill gaps between the children of the advantaged and the children of the disadvantaged, during early and late childhood. Residential sorting across neighborhoods and schools is strong.

This paper proceeds in the following way. Section 2 analyzes income mobility in Denmark and the U.S. We examine the sensitivity of estimated income intergenerational elasticities
(IGE) to alternative measures of income. We examine the sources of differences in income mobility. We also report nonparametric estimates of income mobility. Section 3 examines the relationship between schooling attainment, measures of family financial resources, cognitive and non-cognitive skills of children at age 15, family background (education and home environment), and measures of schooling quality. We report surprisingly similar effects of family influence on educational attainment in both societies. We show a link between welfare benefits and educational attainment in Denmark. We discuss the role of neighborhood sorting on child educational attainment. Section 4 qualifies our analysis. Section 5 concludes.

2 Income Mobility

This section explores alternative measures of intergenerational income mobility. Different measures of income convey very different impressions of social mobility. We show how the levels of transfers, the mapping of education to income, the levels and progressivity of taxation, and income inequality differ between the U.S. and Denmark. All four factors affect estimates of income mobility.

We report estimates of Nonlinear Intergenerational Income Elasticities (NL–IGE) for both countries. We find different patterns depending on which income measure we consider. Differences favoring Denmark appear at the lowest and the highest levels of income.

2.1 Data

U.S. data. We use two U.S. data sources. We use PSID data for our main analysis of intergenerational income mobility. We measure parental income using a 9-year average from
the child’s 7th to 15th year. Child income is measured as income at ages 34–41 down to ages ranging from 30–35 for the 1972 to 1978 birth cohorts, respectively. In our main analysis we only consider individuals with positive incomes. Web Appendix gives further details.

As the sample size for the PSID data is small (relative to the Danish data), we use the March Current Population Survey (CPS) (1968–2014) from Integrated Public Use Microdata Series (IPUMS) when we use U.S. income distributions in the analysis. The sample consists of civilian, non-institutionalized citizens. We use parents in 1987 and individuals age 36–38 in 2011.

**Danish data** For Denmark we use the full population register data on the entire cohorts born in 1973–1975. We discard individuals who migrate (or whose parents migrate), individuals for whom we have no identification of the father or mother (around 2%), and individuals with negative incomes (average over the period where we measure income). Parental income is measured as a 9-year average from when the child is 7–15 years of age and the child’s income is measured at ages 35–37, 36–38, and 37–39 for the 1975, 1974, and 1973 cohorts, respectively. The full sample size is 166,359, and once we restrict to positive incomes the sample is reduced to 149,190 individual parent-child matches.

Table provides the definitions of the various income measures we consider. Table in the Web Appendix summarizes income levels for the U.S. and Denmark by different quantiles and income measures, and Figure depicts the distributions. The table and figure show that incomes in Denmark are more compressed than incomes in the U.S. There is a large low-income

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1 Throughout the analysis we use total parental income and do not adjust for differences in household size by the number of siblings.

2 All calculations are weighted by CPS sampling weights and are deflated using PCE deflator.

3 Throughout the paper we use a PPP adjusted exchange rate of $100 to DKK 776 (as reported by the OECD).

4 Table presents results where we sample cohorts in the Danish register data with the same distribution as observed in the PSID data, and where we sample the number of observations in each cohort as observed in the PSID data. The results do not differ significantly or qualitatively from our main results which we will present in Table.
group in the U.S. that almost does not exist in Denmark (Aaberge et al., 2002; Corak, 2013; Forslund and Krueger, 1997). In the next section, we show that cross-sectional differences in income distributions between Denmark and the U.S. are an important source of higher income mobility in Denmark than in the U.S.

2.2 Linear Intergenerational Income Elasticities

A large literature investigates the association between parents’ and children’s income. The modal statistic used to study income mobility is the intergenerational elasticity (IGE) of income $\beta_{IGE}$:

$$\ln(Y_C) = \alpha + \beta_{IGE}\ln(Y_P).$$ (1)

The father/son or parent/child IGE is generally found to be much higher in the U.S. than in Denmark. Estimates generally lie between 0.3 and 0.5 in the U.S. and around 0.1 to 0.2 in Denmark (Björklund and Jäntti, 2011; Blanden, 2013; Mazumder, 2005; Solon, 2002). There is a similar range for rank-rank associations. Boserup et al. (2013) and Chetty et al. (2014) estimate this to be 0.18 in Denmark and 0.34 in the U.S., respectively. Based on these estimates of the income IGE, Scandinavia is portrayed as a "land of opportunity." Cross-country differences in estimated IGEs of income can arise for a multitude of reasons that we attempt to capture using different income measures. One measure proxies transmission of total individual income potential with wage earnings, capital income, and profits.

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See Section B in the Web Appendix. Freeman et al. (2010) discuss a broad range of likely causes and consequences of wage-compression for the Swedish welfare-state. See also Aaberge et al. (2000), Pedersen and Smith (2000), and Tranæs (2006), who provide similar evidence from Denmark.

See, e.g., Blanden (2013), Corak (2006), and Solon (2002) for reviews of the literature.

See Table 5 in the Appendix to this text for a summary of previous IGE estimates for Denmark (comprehensive) and the U.S. (selected).
Another proxies transmission of total income including public transfers. A third measure introduces the effects of the progressivity of the taxation on income mobility. A fourth measure, wage earnings, proxies intergenerational transmission of earnings-potential rewarded in labor market—differences arise, in part, from differences in returns to education.

A further source of differences in estimated IGEs arises from differences in levels and trends in cross-sectional income inequality. We put this issue aside for now, and investigate it in the next subsection.

Table 1 shows estimated intergenerational income elasticities for similar income measures in Denmark and the U.S. The odd-numbered columns report estimates for Denmark. The even-numbered columns report the corresponding estimates for the U.S.

Column 1 shows that the estimated IGE based on gross income, excluding public transfers, is 0.352 for Denmark. This estimate is much higher than estimates reported in the literature that use wage earnings, earnings, or income including public transfers. The corresponding estimate for the U.S. is 0.312. The difference between the two estimates is not statistically significant. The third and fourth columns show that the estimated IGE for Denmark drops by around 20% to 0.271 when public transfers are included in the measure of income. This decrease illustrates the important role of redistribution in Denmark. For the U.S., the corresponding estimate jumps to 0.446, bringing us close to the estimate reported in Solon (1992) and Chetty et al. (2014) (see Table 5 in the Appendix to this text). Comparing the estimate in column 3 in Table 1 to that of column 9 in the same table, we see that adding taxation reduces the Danish IGE estimate further. Unfortunately, we do not have the data required to estimate the

\[8\]
But not the impact of in-kind transfers.

\[9\]
The previous literature investigating social mobility has long addressed some of the issues. One early example is Solon (1992).
When we focus on wage earnings alone in columns 5 and 6, the estimated IGE for Denmark drops dramatically to 0.081, while the corresponding U.S. estimate is 0.289. Finally, adding public transfers to wage earnings results in an even larger gap between the two countries. For wage earnings plus public transfers, the Danish IGE is 0.063 while the U.S. is 0.419.

Our estimates for Denmark do not contradict the findings of the previous literature. Rather, they enrich our understanding of them. Measured by income potential (column 1 and 2), we find that intergenerational mobility in Denmark is not significantly different from intergenerational mobility in the U.S. When we account for public transfers, estimates for the two countries diverge. Income mobility by this measure is substantially higher in Denmark than in the U.S. When we consider wage earnings alone or wage earnings inclusive of public transfers, we obtain estimates for Denmark reported in the previous literature with estimated IGEs around 0.1.

Table A3 in the Web Appendix shows IGE estimates while controlling for child’s highest completed grade. The table shows that controlling for own education reduces the IGE estimates by approximately 1/3 relative to the unadjusted estimates presented in Table 1. Yet the overall differences between income measures and countries remain unchanged. IGE estimates are similar for Denmark and the U.S. for gross income excluding transfers, but diverge for other income measures. In addition, it is evident from the table that the coefficients for child’s highest completed grade on income are larger in the U.S. than in Denmark. Furthermore, the coefficients for child’s highest completed grade for Denmark decrease substantially when we consider income measures including transfers or post-tax income, whereas they are unaffected by the inclusion of transfers for the U.S.

In Table A4 in the Web Appendix, we show the corresponding IGE estimates while controlling for parents’ education. The estimated elasticities decrease by 25–30%, but we find no sign of any patterns or cross-country difference that is not present for the unadjusted IGE estimates in Table 1.
Table 1: IGE estimates with different income measures Denmark and the U.S.

<table>
<thead>
<tr>
<th></th>
<th>Gross income excl. public transfers</th>
<th>Gross income incl. public transfers</th>
<th>Wage earnings</th>
<th>Wage earnings and public transfers</th>
<th>Net-of-tax total gross income</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1) Denmark</td>
<td>(2) U.S.</td>
<td>(3) Denmark</td>
<td>(4) U.S.</td>
<td>(5) Denmark</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.352***</td>
<td>0.312***</td>
<td>0.271***</td>
<td>0.446***</td>
<td>0.083***</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.055)</td>
<td>(0.003)</td>
<td>(0.054)</td>
<td>(0.003)</td>
</tr>
<tr>
<td>Observations</td>
<td>149,190</td>
<td>621</td>
<td>149,190</td>
<td>621</td>
<td>149,190</td>
</tr>
</tbody>
</table>

Note: Table shows coefficients ($\beta_{IGE}$) and standard errors from regressions of child log income on parents’ log income for Denmark and the U.S. For Denmark, we use full population register data for children born in 1973–1975, and for the U.S. we use PSID data children born in 1972–1978. For Denmark, parental income is measured as a 9 year average from the child’s 7th to 15th year and the child’s income is measured at ages 35–37, 36–38, and 37–39 for the 1975, 1974, and 1973 cohorts, respectively. For the U.S., parental income is measured as a 9 year average from the child’s 7th to 15th year and the child’s income is measured as last year income at ages 34–41, 33–40, 32–39, 31–38, 30–37, 30–36, and 30–35 for the 1972, 1973, 1974, 1975, 1976, 1977 and 1978 cohorts, respectively.

Total gross income excl. public transfers
1 Denmark: All taxable income including wage earnings, profits from own business, capital income, and foreign income excluding all public transfers (both taxable and non-taxable).
2 U.S.: All taxable income including earnings (payroll income from all sources, farm income, and the labor portion of business income), asset income (such as rent income, dividends, interest, income from trust and royalties, and asset income from business), and private transfers (such as income from alimony, child support, and help from relatives and others).

Total gross income incl. public transfers
3 Denmark: All taxable income including wage earnings, public transfers, profits from own business, capital income, and foreign income.
4 U.S.: All taxable income including earnings, asset income, private transfers and public transfers (such as social security income, SSI, TANF, ETC, other welfare income, retirement, pension, unemployment, and workers compensation).

Wage earnings
5 Denmark: Taxable wage earnings and fringes, labor portion of business income, and non-taxable earnings, severance pay, and stock-options.
6 U.S.: Payroll income from all sources (such as wages and salaries, bonuses, overtime income, tips, commissions, professional practice, market gardening, additional job income, and other labor income), farm income, and labor portion of business income.

Wage and public transfers
7 Denmark: Taxable wage earnings and fringes, labor portion of business income, and non-taxable earnings, severance pay, and stock-options, plus taxable and non-taxable public transfers (social assistance, unemployment benefits, labor market leave, sick leave assistance, labor market activation, child-benefits, education grants, housing support, early retirement pension, disability pension, and retirement pension).
8 U.S.: Payroll income from all sources, farm income, labor portion of business income, and public transfers.

Net-of-tax total gross income
9 Denmark: Total gross income minus all final income taxes paid in given year. We do not have information on individual net-of-tax income from the PSID.
One should generally interpret cross-country differences with great caution. There is no single best measure of the IGE. We do not claim that we have shown that levels of income mobility in the U.S. and Denmark are alike or different. The conclusion from this analysis is that accounting for transfers, wage compression, returns to education, and progressive income taxation explains a substantial portion of the Denmark-U.S. difference in associations between children’s and parents’ income.

In addition, several measurement problems discussed in the previous literature (see, e.g., Solon, 2004) might also affect estimated IGEs. Imputing zeros with an arbitrary value affects estimates. Censoring may also produce biased results, for example, by leaving out the long-term unemployed from the analysis. Table A5 in the Web Appendix reports the corresponding estimates of Table 1 when imputing zero incomes with $1,000. The table shows that estimated IGEs change for income categories that include many zeros (gross income excluding transfers and wage earnings). Nevertheless, the overall patterns from Table 1 remain unchanged for Denmark. For the U.S., the PSID data is, however, much more sensitive to the inclusion of zero and non-reported incomes. In order to obviate the problems with zero income, analyses estimating relationships between child and parents’ ranks in their respective income distributions have recently been used (see Dahl and DeLeire, 2008 and Chetty et al., 2014). We do not report results for rank-rank estimates in the main text and refer readers to

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12 Additional measurement problems include life cycle bias and measurement error from year-to-year variation in income. We attempt to avoid these potential biases by considering parental and child income measured as averages over several years (permanent income) and by measuring children’s income when they are in their late 30s.

13 For Denmark, estimated IGEs increase the smaller number used to make the imputation. When we use $1,000, the estimated IGE for gross income excluding transfers is 0.49, and when we use $1 it increases to around 0.6.

14 $\beta_{RR}(rank - rank) = \text{Corr}(R(Y^P), R(Y^C))$ where $R(*)$ denotes children’s and parents’ rank in their respective distributions. While $\beta_{RR}$ is scale invariant in income, $\beta_{IGE}$ is not. The link between the two measures depends on the underlying distributions (see Trivedi and Zimmer, 2007).
2.3 The Role of Inequality in Shaping the IGE

The cross-country correlation between income mobility and income inequality has received a lot of attention in the past decade (Corak, 2006, Krueger, 2012) calls this the Great Gatsby curve. In this subsection, we examine the mechanical relationship between estimated IGE and changes in inequality across generations. It follows the definition of the IGE,

\[ \beta^{IGE} = \text{corr}(\ln(Y^C), \ln(Y^P)) \frac{sd(\ln(Y^C))}{sd(\ln(Y^P))}, \]

that increase in inequality from one generation to the next amplifies the estimate without affecting mobility measured by correlation coefficients. Hence, differences in inequality between

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15Table A6 in the Web Appendix replicates this analysis for rank-rank regressions. The findings are qualitatively similar. For total gross income excluding transfers, the Danish estimates are close to the U.S. levels reported by Chetty et al. (2014, Table 1, line 7, column 1). When we consider wage earnings alone and/or include public transfers, large cross differences arise (compare Danish levels to Chetty et al., 2014, Table 1, line 8, column 1).

16Rank-rank analyses do not solve the issues that the researcher faces when using log income. We refer the reader to Web Appendix C for discussion. Web Appendix C presents further results on two of the additional issues often discussed in the previous literature on income mobility. For a recent review, see Black and Devereux (2011). The first issue is life cycle bias, i.e., that associations between children’s and parents’ income will be ‘understated’ if children’s income is measured early in their working career, where yearly earnings do not reflect life-time earnings. We show that the rank-rank slopes for Denmark do not stabilize until the child’s income is measured during his/her late 30s (see Figure A42 in the Web Appendix and Nybom and Stuhler, 2015 for similar evidence from Sweden). We also illustrate that measuring parental income earlier in the child’s life reduces the rank-rank slopes. (In Denmark, measuring children’s income during their early 20s actually results in negative coefficients.) The second issue is attenuation bias (measurement error bias) that stems from the noise arising from including too few years of income data (Solon, 1992). In the Danish data, this can be much larger than the levels reported in Chetty et al. (2014). When we measure parental income when the child is below 10 years of age and add income data from subsequent years to the analysis, the differences in rank-rank slopes based on 1 and 5 years of data, respectively, range from 12–32% depending on which income measure is used (see Figure A43). However, when we use income measured during the child’s late teens and add data from preceding years, the corresponding 1–5 year differences are around 0–3% in accord with Chetty et al.’s analysis.

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generations and countries may generate differences in perceived income mobility.\textsuperscript{17}

Table 2 shows how differences in variances drive estimates. The table shows the regression coefficients from Table 1 together with the correlation and intergenerational ratio of standard deviations below each coefficient. The table shows that, although not statistically significantly different, the intergenerational correlation for gross income excluding transfers in the U.S. is above its Danish counterpart. It is the ratio of standard deviations that drives the Danish IGE to levels above the U.S. When public transfers are included in gross income, the correlation and ratio increase in the U.S., while in Denmark the ratio decreases and correlation is roughly unchanged. These results also emphasize that transfers are more progressive and constitute a larger fraction of income in Denmark compared to the U.S. Furthermore, the table shows that the large increase in the estimated IGE for the U.S. when public transfers are included, partly arises because transfers reduce inequality in parents’ income while inequality in children’s income is largely unaffected.\textsuperscript{18} When we focus on wage earnings alone, the correlation in Denmark drops from a level of 0.21 to 0.08, whereas in the U.S. the intergenerational correlation remains at an unchanged level.\textsuperscript{19} Table A5 in the Web Appendix presents a corresponding analysis imputing zero incomes with $1,000. The main difference for Denmark is that intergenerational correlations for gross income excluding transfers and wage earnings increase to 0.246 and 0.118, respectively, while the correlations for the remaining

\textsuperscript{17}In a similar vein, one might question how differential trends in educational inequality affect comparisons across countries with high rates of high school and college degrees in earlier generations, as in the U.S., and countries where high school and college degrees become modal only over the past 30–50 years, as in Denmark and Norway. This remains an open question.

\textsuperscript{18}This is also shown in Figure A24 in the Web Appendix, where we use CPS data for the U.S. and register data for Denmark to plot average wage earnings and wage earnings plus transfers in the two countries across different educational levels for the cohorts born 1947–1978.

\textsuperscript{19}In Tables A8–A12 in the Web Appendix we report the intergenerational correlations and standard deviations of all major income components for Denmark. The tables show that the increased ratio of standard deviations from wage earnings to gross income stems from capital income and profits from own businesses. The ratio of standard deviations changes drastically for gross income because the covariance between wage earnings and profits is negative for parents and zero for children, thus reducing the overall variance of parents’ income relative to children’s income.
incomes measure remain largely unaffected. Hence, including individuals with zero incomes, there is a substantial reduction in the intergenerational correlation when we add transfers to gross income in Denmark.

Table 2: Intergenerational correlations and inequality for different income measures Denmark and the U.S.

<table>
<thead>
<tr>
<th></th>
<th>Gross income excl. public transfers</th>
<th>Gross income incl. public transfers</th>
<th>Wage earnings</th>
<th>Wage earnings and public transfers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Denmark (1)</td>
<td>U.S. (2)</td>
<td>Denmark (3)</td>
<td>U.S. (4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\beta_{IGE}$</td>
<td>0.352***</td>
<td>0.312***</td>
<td>0.271***</td>
<td>0.446***</td>
</tr>
<tr>
<td>$\rho_{\text{Child},\text{Parents}} \frac{\text{sd(Child)}}{\text{sd(Parents)}}$</td>
<td>0.201 0.860 0.489</td>
<td>0.268 0.977 0.840</td>
<td>0.214 0.375 0.308</td>
<td>0.318 0.906 0.645</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Table shows coefficients ($\beta_{IGE}$) and standard errors from regressions on parental log income on child’s log income from Table 1 together with the correlation multiplied with the ratio of the standard errors $\beta_{IGE} = \rho_{\text{Child},\text{Parents}} \frac{\text{sd(Child)}}{\text{sd(Parents)}}$ for Denmark and the U.S.

From this analysis, we see that IGE estimates are sensitive not only to the income measures used, but also to inequality levels and changes. It is not meaningful to compare IGE estimates, when arbitrary large or small levels of inequality drive the estimates. In order to investigate this issue more deeply, we conduct a further analysis showing the sensitivity of IGE estimates to adjustments for inequality.

We present regressions where we transform the different income distributions for Denmark to the corresponding income distributions for the U.S., holding income ranks fixed. Then we place the U.S. distribution in the Danish distribution. In the upper panel of Table 3, we present IGE estimates where quantiles of the Danish distributions (for parents (reported in the rows) and children (reported in the columns)) are mapped into the equivalent income measures for the U.S. for children born in 1973–1975 in 2011 with parents in the 1987 March CPS data. Figure A2a in the Web Appendix illustrates the transformation for wage earnings distributions.
The child or parent with the \( n^{th} \) total gross income rank in Denmark is assigned the total gross income level associated with the \( n^{th} \) rank of total gross income for the U.S. child or parent distribution. A similar transformation is used for total income excluding public transfers, total net-of-tax income, wage earnings, and wage earnings plus public transfers. Using this method, we illustrate what the Danish IGE would be for the different income measures, if Denmark had the same level of inequality within generations as those found in the U.S.

In the lower panel of Table 3, we do the opposite, which is illustrated in Web Appendix Figure A2b. In this case, quantiles of the U.S. distributions are mapped into the equivalent income measures in 2010–2012 for Danish for children born in 1973–1975 and their parents using Danish register data. Hence, we illustrate what the U.S. IGE would be for the different income measures, if the U.S. had the same level of inequality within generations as those found in Denmark.

The columns and rows labeled \textit{Baseline distribution} for both parents and children show the actual IGE coefficients from Table 1. The first line in the upper panel shows that if Danes born between 1973 and 1975 had the same income distribution as the corresponding U.S. age cohorts, the Danish IGE estimates for gross income excluding transfers, including transfers, and net-of-tax would increase by 50 to 100\%, whereas it would be unchanged for wage earnings. In the next thought experiment, we examine the consequences of giving Danish parents the same income distribution as U.S. parents. Estimated IGEs would decrease. Transforming children’s and parents’ income distribution reduces IGEs by 30–50\% when we consider the gross income measures, and increase IGEs by roughly 50–100\% when we consider wage earnings and wage earnings plus transfers.

When we perform the equivalent exercise for the U.S., we naturally reach the opposite conclusion. Changing income distribution of children and holding parents’ income distributions fixed results in large reductions in the IGE, while changing income distributions for parents
and holding children’s income distributions fixed results in large increases in the IGE. Finally, by transforming both generations’ income distributions, the IGE by gross income excluding transfers increases, the IGE transfers decrease, and the IGE for wage earnings is unchanged.

Table 3 shows that IGEs in Denmark and the U.S. are quite different when wage earnings and wage earnings plus transfers are used as measures of income. Estimated IGEs based on these two income measures are robust to the changes in inequality we observe for both countries. For the remaining measures of income, the similarities between the IGEs in Denmark and the U.S. are substantial and depend strongly on trends and levels in inequality.

The analyses presented in this section emphasize that levels of estimated income (im)mobility often is in the eye of the beholder. Not only do estimates vary by income measures, they are also affected by whether changing inequality is linked to mobility. For example with a fixed correlation between children’s and parents’ income, doubling income inequality from one generation to the next clearly increases differences in income levels and the consumption possibilities between children from high income and low income families. Should the chosen measure of income mobility capture such change? Without specifying a social welfare function and a normative definition of fairness, this question does not have a clear answer.
Table 3: IGE estimates with different income measures, imposing U.S. income distribution to Danish distribution and vice versa

<table>
<thead>
<tr>
<th>Distribution</th>
<th>Gross income excl. public transfers (1)</th>
<th>Gross income incl. public transfers (2)</th>
<th>Net-of-tax total gross income (3)</th>
<th>Wage earnings (4)</th>
<th>Wage earnings and public transfers (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A: U.S. distribution imposed on Danish</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline Parent</td>
<td>0.352***</td>
<td>0.435***</td>
<td>0.271***</td>
<td>0.600***</td>
<td>0.221***</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.005)</td>
<td>(0.003)</td>
<td>(0.008)</td>
<td>(0.003)</td>
</tr>
<tr>
<td>Transformed Parent</td>
<td>0.187***</td>
<td>0.230**</td>
<td>0.093***</td>
<td>0.213**</td>
<td>0.093**</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.001)</td>
<td>(0.003)</td>
<td>(0.001)</td>
</tr>
<tr>
<td><strong>B: Danish distribution imposed on U.S.</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline Parent</td>
<td>0.308***</td>
<td>0.207***</td>
<td>0.433***</td>
<td>0.186***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.051)</td>
<td>(0.042)</td>
<td>(0.060)</td>
<td>(0.028)</td>
<td></td>
</tr>
<tr>
<td>Transformed Parent</td>
<td>0.666***</td>
<td>0.501***</td>
<td>0.734***</td>
<td>0.337***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.095)</td>
<td>(0.079)</td>
<td>(0.105)</td>
<td>(0.048)</td>
<td></td>
</tr>
</tbody>
</table>

Note: Table shows coefficients ($\beta_{\text{IGE}}$) and standard errors from regressions on child log income on parents’ log income for children born in 1973–1975. Income measures for parents and child are the same in each regression, i.e., parent wage on child’s wage, etc. For the baseline in panel A (Denmark): Parental income is measured as a 9 year average from the child’s 7th to 15th year and the child’s income is measured at ages 35–37, 36–38, and 37–39 for the 1975, 1974, and 1973 cohorts, respectively. For the baseline in panel B (U.S.): Income measures for parents and child are the same in each regression, i.e., parent wage on child’s wage, etc. Parental income is measured as a 9 year average from the child’s 7th to 15th year and the child’s income is measured as last year income at ages 34–41, 33–39, 32–38, 31–36, 30–36, and 30–35 for the 1972, 1973, 1974, 1975, 1976, 1977, and 1978 cohorts, respectively.

Columns labeled Baseline show IGE of income where child’s income distribution is unchanged. Columns labeled Transformed Child show IGE of income where children’s income distribution has been changed to fit the distributions of the corresponding income measures for the U.S. in panel A and the corresponding income measures for Denmark in panel B. Rows labeled Baseline Parent shows IGE of income where parents’ household income distribution is unchanged. Rows labeled Transformed Parent show IGE of income where parents’ household income distribution has been changed to fit the reported income distributions for corresponding income measures for the U.S. in Panel A and for Denmark in Panel B.

1–2 Total gross income excl. public transfers

Denmark: All taxable income including wage earnings, profits from own business, capital income, and foreign income excluding all public transfers (both taxable and non-taxable). U.S.: All taxable income including earnings (payroll income from all sources, farm income, and the labor portion of business income), asset income (such as rent income, dividends, interest, income from trusts and annuities, and asset income from business), and private transfers (e.g., alimony, child support, and help from relatives).

3–4 Total gross income incl. public transfers

Denmark: All taxable income including earnings, public transfers, profits from own business, capital income, and foreign income. U.S.: All taxable income including earnings, asset income, and private and public transfers (such as social security income, SSI, TANF, etc., other welfare income, retirement, pension, unemployment, and workers compensation).

5–6 Net-of-tax total gross income Denmark: Total gross income minus all final income taxes paid in given year

7–8 Wage earnings

Denmark: Taxable wage earnings, fringes, labor part of business income, and non-taxable earnings/severance pay/stock-options. U.S.: Payroll income from all sources (wages, salaries, bonuses, overtime income, tips, commissions, professional practice, market gardening, additional job income, and other labor income), farm income, and labor part of business income.

9–10 Wages and transfers

Denmark: Taxable wage earnings and fringes, labor portion of business income, and non-taxable earnings, severance pay, and stock-options. U.S.: Payroll income from all sources, farm income, labor portion of business income, and public transfers.

Number of observations: A upper panel 149,190; B lower panel 621.

*aThis is a radial transformation quantiles of Danish child income distribution mapped into quantiles of comparable measures of U.S. distribution.
2.4 Nonlinear Intergenerational Income Elasticities

It is likely that any benefits from the Scandinavian welfare states accrue to the least advantaged. This is a feature that linear models of the IGE might fail to adequately capture. Thus, it is particularly interesting to analyze nonlinearities in the IGEs. Wage compression and the high level of redistribution via taxes and transfers only add weight to the relevance of considering possible nonlinearities.

Yet, few previous studies consider nonlinearities. Bratsberg et al. (2007) report that the relationship between the logarithm of child and parent income is convex in Denmark (and in Scandinavia more generally) and concave in the U.S. for measures of wage earnings. They attribute this finding to higher mobility for individuals from low income families in Denmark than in the U.S. We replicate these findings in Figure A3 in the Web Appendix. However, as previously emphasized, results differ according to which income measure is used. In Denmark for example, wage earnings of children and parents display a convex relationship, while for total gross income excluding public transfers the relationship is linear, or perhaps even concave.

To account for nonlinearities, we estimate the Nonlinear Intergenerational Income Elasticity (NL-IGE) $\beta_{\text{IGE}} \left[\ln(Y^P_0)\right]$, where $Y^P_0$ is the income of the parent at $Y_0$ and $Y^C$ is income of the child, using Local Linear Regressions:

$$\min_{\alpha[\ln(Y^P_0)], \beta[\ln(Y^P_0)]} \sum_{i=1}^{N} K_{h_{\lambda}}(Y^P_0, Y^P_i) \cdot \{\ln(Y^C_i) - \alpha[\ln(Y^P_0)] - \beta_{\text{IGE}}[\ln(Y^P_0)]\ln(Y^P_i)\}^2.$$ (2)

It is feasible to estimate the NL-IGEs using absolute income, thereby obviating the problem

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20 Bratsberg et al. (2007), Chevalier et al. (2013), and Davies et al. (2005) also study nonlinearities.
21 Estimates closely resemble the slopes found in the plots of log of child and parental income in Figures A3 and A4 in the Web Appendix.
that ln(0) does not exist. However, the estimation of NL-IGE using absolute income involves a tradeoff in terms of precision for high income levels due to the right tail of the income distribution. Doing so reduces the precision of estimates substantially. In order to be able to compare estimates from $10,000–125,000 and not just from $30,000–60,000 of parental incomes, we therefore report estimates using log income here. The equivalent point estimates using absolute income are very similar to the results shown in the main text and are reported in Web Appendix Figures A5 and A6.

Figures 1 and 2 show plots of NL-IGE estimates of log income, weighted with absolute income, without imputation for zero income for Denmark and the U.S. The vertical lines in the figures mark the 5th and 95th percentiles in the income distributions in the Danish data and the 5th and 95th percentiles for the U.S. data. These estimates only allow us to infer local conclusions about mobility. A zero IGE estimate at a low level of income does not imply that going from rags to riches is likely. It only shows that a marginal movement up (or down) in income levels relative to parental income is just as likely as a status quo. The figures present estimates for the income ranges where the data allows us to make meaningful estimates (because there is very limited support for high incomes in the PSID).

Figure 1 shows NL-IGE estimates for gross income excluding public transfers and gross income including public transfers for Denmark and the U.S. (Figures 1a and 1b). The elasticity goes from levels around 0.25 to almost 0.4 when parental income increases from $0 to $100,000. Thereafter, the estimates slowly decline and reach a level of around 0.1–0.2 at the 99th percentile of parental income. The corresponding results for the U.S. (in Figures 1c and 1d) show that elasticities at low income levels closely correspond to those in Denmark, although they are

\[ K_{h\lambda}(Y_{0}, Y_{i}) \] is an Epanechikov kernel. One should note that it is important to distinguish between a kernel with absolute income \( K_{h\lambda}(Y_{0}^{P}, Y_{i}^{P}) \) which we use here, and a kernel with log income \( K_{h\lambda}(\ln(Y_{0}^{P})), (\ln(Y_{i}^{P})) \). The former assigns symmetric weight around \( Y_{0}^{P} \) while the latter weighs observations above \( Y_{0}^{P} \) more because of the logarithmic transformation. Finally, the imputation of zero incomes inflates estimates of NL-IGEs at the low to medium parental income range (the parental income ranges where zero incomes for children are most prevalent).
imprecisely estimated. In the U.S., elasticities increase monotonically with parental income. At the 95th percentiles of parental gross income excluding and including public transfers, U.S. intergenerational income elasticities are well above 0.5.

Figure 2 graphs NL-IGE estimates for wage earnings and wage earnings plus public transfers for Denmark (a and b) and the U.S. (d and e), and net-of-tax total gross (disposable) income for Denmark (c). Figures 2a and 2b show functional forms similar to those from Figures 1a and 1b. Elasticities at low levels of income are approximately 0.1, or even lower, and increase monotonically until parental income reaches $110,000. After this point, the elasticities decrease. For the U.S., the figures also show a monotonic upward slope but with levels well above the Danish estimates at all points. Finally, elasticities for net-of-tax income in Denmark are initially flat at roughly 0.25 but go towards zero as parental income increases beyond the 99th percentile.
Figure 1: Local Intergenerational Income-Elasticity in Denmark and the U.S.

Denmark
(a) Total gross income excl. public transfers
(b) Total gross income incl. public transfers

U.S.
(c) Total gross income excl. public transfers
(d) Total gross income incl. public transfers

Note: Figures show estimated Intergenerational Income-Elasticities of wage income plus public transfers for Denmark (a, b) and the U.S. (c, d). Figures a and b have been constructed using full population register data from Denmark, and Figures c and d have been constructed using PSID data. The figures show local linear regression slopes of log of children’s income on log of parental income. LLRs are weighted using kernels of absolute income. Standard errors for Figures a and b have been constructed from 50 bootstraps and standard errors for Figures c and d have been constructed from 1,000 bootstraps. The vertical lines indicate the 5th and 95th percentiles in the respective income distributions.
Figure 2: Local intergenerational income-elasticity in Denmark and the U.S., cont.

Note: Figures show estimated Intergenerational Income-Elasticities of wage income plus public transfers for Denmark (a, b, c) and the U.S. (d, e). Figures a, b, and c have been constructed using full population register data from Denmark, and Figures d and e and have been constructed using PSID data. The figures show local linear regression slopes of log of children’s income on log of parental income. LLRs are weighted using kernels of absolute income. Standard errors for Figures a, b, and c have been constructed from 50 bootstraps and standard errors for Figures d and e have been constructed from 1,000 bootstraps. The vertical lines indicate the 5th and 95th percentiles in the respective income distributions.
In order to get a more precise view of the cross-country differences in NL-IGEs, Figure 3 plots the differences between the U.S. and the Danish elasticities across levels of parental income. From Figure 3a, we see that income mobility in gross income excluding public transfers is roughly similar for family incomes up to $100,000. From this point onward, a gap emerges which—albeit imprecisely estimated—continues to increase. Income mobility by gross income excluding transfers is much lower in the U.S. than in Denmark for top quartile family incomes, but not for families with low income. When transfers are added to income, as shown in Figure 3b, the elasticities in the U.S. are persistently above the Danish elasticities with a widening gap at high incomes. When we only consider wage earnings in Figure 3c, the Danish IGE is around 0.2 lower than the U.S. IGE across all parental income levels. This result also dovetails nicely with our argument about the importance of wage compression in Denmark as opposed to the increasing return to education in the U.S. being key mechanisms behind the observed income mobility differences. Finally, Figure 3d shows that for wage earnings plus transfers, intergenerational income elasticities in Denmark are consistently below U.S. levels. Here, the Danish IGE is around 0.35 lower than the U.S. IGE at low income levels and 0.25 lower at high income levels. Hence, the largest difference between income mobility in Denmark and the U.S. is now for the lowest family incomes.
Figure 3: U.S.-Denmark difference in local Intergenerational Income-Elasticity

(a) Total gross income excl. public transfers

(b) Total gross income incl. public transfers

(c) Wage earnings

(d) Wage earnings and transfers

Note: Figures show U.S.-Denmark difference in local Intergenerational Income-Elasticities from Figures 1 and 2. The figures show the U.S. IGE estimate minus the Danish estimate, such that a positive value indicates a larger IGE estimate for the U.S. than for Denmark and a negative value indicates the opposite.
3 Educational Mobility by Family Background

In the previous section, we studied intergenerational income mobility across two countries and show that wage compression and tax/transfer policies are major determinants of cross-country differences in mobility. Although the reward for education may be lower in Denmark, its generous support of education, support of child care, and early education initiatives promotes skill formation as measured by test scores among the disadvantaged.

Many point to the more generous educational and child care policies in place in Denmark as a source of its greater social mobility (see, e.g., Sanders 2013). We examine this claim and show that average educational mobility is remarkably similar across the two countries. We start by demonstrating the near-universal participation in such programs in Denmark coupled with a lack of educational and income differences compared to the U.S.\(^{23}\)

Figures 4a and 4b show the fraction of children enrolled in preschool programs at the age of 4 in the U.S. and Denmark from 1995 to 2005.\(^{24,25}\) The figures show overall rates together with

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\(^{23}\)Throughout this section we use a variety of data sources. We discuss these briefly in the main text. Web Appendix Section F describes them in detail.

\(^{24}\)See Tables A13 and A14 in the Web Appendix for an overview of the expenditures on education systems in the U.S., Denmark, and the rest of Scandinavia. They demonstrate the greater generosity of the Danish system measured in a variety of ways. Expenditures on preschools are especially generous. Currie (2001) and Simonsen (2010) give detailed descriptions of expenditures and pricing schemes in early education in the U.S. and Denmark, respectively.

\(^{25}\)The Scandinavian daycare and preschool system is rooted in a social pedagogy tradition as opposed to many other European countries and the U.S., which focus more on an educational approach. The English-speaking world have adopted a ‘readiness for school’ approach, which although defined broadly focuses in practice on cognitive development in the early years, and the acquisition of a range of knowledge, skills, and dispositions. A disadvantage inherent in this approach is the use of programmes and approaches that are poorly suited to the psychology and natural learning strategies of young children. In countries inheriting a social pedagogy tradition (Nordic and Central European countries), the kindergarten years are seen as a broad preparation for life and the foundation stage of lifelong learning.’ (Organisation for Economic Co-operation and Development 2006 pp. 2). The Nordic approach is summarized as ‘The core of the curriculum is the dialogue between adult and child and creative activities, discussions and reflections. The curriculum sets goals for early education, but is flexible so that it can be adapted to local and individual needs.’ (Organisation for Economic Co-operation and Development 2001). In recent years, however, early childhood care in Denmark has increased its focus on education as well (see Jensen et al. 2010 for a discussion).
the rates for children for whom both parents have fewer than 12 years of schooling (less than high school) and children for whom both parents have at least 15 years of schooling (college or more). The figures show that average preschool enrollment rates at age 5 were, on average, similar in the two countries in 1995. Since then, rates of participation have stagnated in the U.S. and increased to a level close to full uptake in Denmark. Importantly, the figures also show large gaps in enrollment rates by parental education in the U.S., whereas there are no differences in Denmark.

Figures 4c and 4d show rates of daycare/preschool use at ages 2, 3, and 4 by parental wage income rank in 2005 in the two countries. Enrollment rates are lower in the U.S., trends in participation are flatter, and family income gradients for participation in the programs are steeper.

A few studies present causal evidence linking access to universal public child care to improvements in skills in a Scandinavian context. Havnes and Mogstad (2011b) study a large expansion of child care in Norway on long-run outcomes. They find that daycare enrollment improves educational attainment and earnings, especially for children from low-resource families. Datta Gupta and Simonsen (2010, 2012) investigate the effects of home care, non-parental/related family care, and public daycare in Denmark on socio-emotional skills. Datta Gupta and Simonsen (2010) find that public daycare relative to family care increases socio-emotional skills at age 7, while Datta Gupta and Simonsen (2012) suggest that the effects may fade at later ages.

An active literature investigates the effectiveness of early childhood interventions in the U.S. The evidence from many U.S. programs may not be relevant to the current discussion,

26 Havnes and Mogstad (2011a,b) show that most of the uptake in publicly provided child care comes from children who were in informal care arrangements. We return to this point in our conclusion.
27 In a child-minder’s home.
28 Currie and Thomas (2000) and Elango et al. (2016) are examples.
as the programs are often very intensive and target specific groups of children. Cascio (2009) reports that large-scale, publicly funded child care programs in the U.S. are less effective than their Scandinavian counterparts. She suggests that low-intensity programs crowd out other programs—for example, Head Start—and divert funding from other public skill formation initiatives.

While the cited studies only investigate policy changes within a given country, they support the claim that increased early childhood investments through universal public child care, improve the skills of the least advantaged children and thus, intergenerational skill mobility. The evidence for their effectiveness is supported by Figure 5 which shows distributions of PISA math and reading scores in Denmark and the U.S. in 2003. The figure shows stark differences in the lower tails of PISA test scores. The lowest quartile in the U.S. performs much worse than the lowest quartile in Denmark.

Yet, despite the greater provision of early childhood education to low-resource families in Denmark, the lack of any pecuniary costs of education in Denmark and the compressed skill distributions, the association between educational attainment levels from one generation to the next are remarkably similar in Denmark and the U.S. Figure 6 shows the fraction of 20–34 year olds in (or with) a tertiary education, by parental educational attainment in Denmark, the U.S., and Norway. The figure shows that only 6–8% of individuals age 20–34 who are enrolled in or have completed a tertiary education come from homes where both parents have not graduated an upper secondary education. Generally, there are few differences in these percentages across the three countries. Figure A13 and Section B.2 (Figure A30) in the Web Appendix corroborate this evidence. Web Appendix Figure A13 shows that educational mobility in Denmark is not higher than in the U.S. if we instead consider regression-based coefficients relating children’s and parents’ educational attainment as reported in Hertz et al.

29Web Appendix Figures A7 and A8 provide similar results for adults using PIACC and IALS data.
Educational transitions across generations are very similar in the two countries for more recent cohorts, as we show in Web Appendix Figure A30.

**Figure 4:** Daycare and preschool use

(a) Trend in preschool participation, age 4, U.S.

(b) Trend in preschool participation, age 4, Denmark

(c) Daycare/preschool by parental income
    U.S., 2005

(d) Daycare/preschool by parental income
    Denmark, 2005

Note: Figures a and b show fraction enrolled in preschool at age 4 from 1995–2007 for all children and by parents’ education. Figures c and d show fraction in daycare/preschool by parental wage income rank within child cohort in 2005. U.S. figures constructed from October CPS data, Danish figures constructed from administrative register data.
Figure 5: Percentage of students at each proficiency level, PISA 2003

(a) Mathematics Scale

(b) Reading Scale


In the rest of this section, we elucidate these findings and investigate the reasons why seemingly similar levels of educational mobility arise. First, we briefly describe the data used in our analyses. We then examine educational attainment by parental resources and which factors help explain the relationship between children’s education and parents’ resources. We also consider explanations that link the findings from our different analyses.
**Figure 6:** Proportion of 20–34 year olds in tertiary education, by parents’ educational attainment, Denmark, Norway, the U.S.

*Note:* Figure shows proportion of 20–34 year olds in tertiary education, by parents’ educational attainment (below upper-secondary, upper secondary or post-secondary (non-tertiary), and tertiary education) in 2012, for Denmark, Norway, and the U.S.

3.1 Data

**U.S. data: CNLSY.** We restrict the sample to cohorts born in 1991 or earlier. In addition to information on own characteristics, we include information on mother’s characteristics from the original NLSY data. We restrict the sample to individuals for whom we observe at least one test score for both cognitive and non-cognitive skills (see below), along with parental income. This leaves us with a sample of 3,268 individuals. We lose 15% due to missing observations and 28% of the remaining sample are born in 1987 or later. See Web Appendix Table A19 for sources of loss of sample information.

**Danish data: 1987 Cohort.** We use the entire cohort of children born in Denmark in 1987. Using a unique individual identifier, we link information on demographic characteristics to schooling outcomes and exam grades in 9th grade. The data also include a unique parental identifier, which allows us to link the information on the children to parental income and wealth, demographic characteristics, and mother’s educational attainment. We restrict the sample to children whose parents have non-negative household wage income in 2002. This results in a sample of 39,539 children.

**Comparability of samples.** There are two fundamental differences between the Danish and U.S. samples. First, while the latter is survey data, the former comes from a full population register based on information reported from relevant institutions and authorities. Second, Danish data are centered around child’s birth year, while consequently, cohorts vary in their characteristics in the two countries. The CNLSY data is centered around parents’ birth year, as it is based on children born from five cohorts of parents. In the CNLSY, we record information

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30 Roughly 10% are born before 1980. Modal years are 1981–1991 where 6.5–8.5% of sample are born each year.
31 Primary school grades are not binding for the child’s further educational trajectory for this cohort.
32 See Web Appendix Table A19 for sources of loss of sample information.
on multiple cohorts of children (before and after 1987) and only five cohorts of mothers. For the Danish data, we consider only one cohort of children born in 1987 and numerous cohorts of parents. We do not censor the data to align parents’ and children’s cohorts between the two countries, as this would induce heavy selection in terms of mother’s age at childbirth. As female fertility patterns are different between the U.S. and Denmark, such selection imposes arbitrary differences between the two countries and could consequently invalidate the analysis.\textsuperscript{33}

**Measuring income and wealth.** In the CNLSY data, we measure parental income using the sum of the mother’s and the spouse’s self-reported wage earnings. In the Danish data, we measure parental income as the sum of the mother’s and father’s wage earnings.\textsuperscript{34} For both countries, we measure income as average income between the child’s 3rd and 15th year. The two income concepts are similar in content.

For the U.S., we measure assets as reported net assets in the CNLSY.\textsuperscript{35} For Denmark, assets are measured as net assets (excluding pension savings) from income and wealth data reported to tax authorities.\textsuperscript{36} In both countries, we measure assets at age 15 of the child. While the data again differ in terms of source, net assets are highly dependent on housing wealth.\textsuperscript{37} Thus, intra-country differences in wealth may capture both differences in market luck in the housing sector, family endowments, and lifetime income.\textsuperscript{38}

\textsuperscript{33}Table A15 presents regression coefficients of parental permanent wage income and wealth on children’s high school completion and college attendance where we sample cohorts in the Danish register data with the same distribution as observed in the CNLSY data, and where we sample number of observations in each cohort as observed in the CNLSY data. The results do not differ significantly or qualitatively from our main results, which we will present in Table 4.

\textsuperscript{34}Results are robust to using gross income including UI and welfare transfers.

\textsuperscript{35}They include value of major owned durables (e.g., housing), as well as debts.

\textsuperscript{36}Includes valuations of major owned durables.

\textsuperscript{37}See Browning et al. (2013) for a discussion of Danish data.

\textsuperscript{38}Home equity comprises a larger share of households’ net wealth in Denmark than in the U.S. In 2010, home equity was estimated as approximately 24% of households’ net wealth in the U.S. (Gottschalck et al. 2013). In Denmark in 2014, this was 37.5% (Statistics Denmark 2016). Reported shares for both countries include pension savings in total net wealth.
Measuring education. In the U.S. data, high school completion is defined using questions on whether or not the child has a high school diploma/GED.\textsuperscript{39} We define college attendance as a report of either full- or part-time enrollment in college. In the Danish data we define high school completion as having completed an education that requires at least 12 years of schooling, which includes both academic and vocational high school graduates, and college as having been enrolled in an education that requires at least 15 years of schooling.\textsuperscript{40}

Cross-country institutional differences are a potential confounder. While we have chosen our definitions of high school completion and college attendance to maintain comparability, we do not (and cannot) control for all cross-country institutional differences. Two potentially

\textsuperscript{39}Cameron and Heckman (1993) and Heckman et al. (2014) show that these two concepts are not equivalent. However, omitting the GED from the definition of high school completion would likely reduce the similarities of Denmark and the U.S., as the Danish measure of high school completion also includes a version of the GED (HF). The HF is a substitute high school degree designed for those who dropped out of high school or earlier educational levels before they completed this. While GPAs from the HF provide access to further education and university as regular academic high school (Gymnasium) does, HF graduates have lower average levels of completed schooling and lower adult income (likely because HF completion instead of Gymnasium completion, for a given GPA, proxies fewer skills on other dimensions (Heckman and Rubinstein, 2001)). Students often take the HF at older ages than normal high school students. Some are high school dropouts while others haven’t enrolled in high school, but dropped out of education after the compulsory years and have spent 5–10 years out of the educational system.

\textsuperscript{40}The Danish educational system is rooted in a Northern European tradition and is not directly comparable to the U.S. system, while secondary and tertiary educations in Denmark are highly comparable to those in countries as Germany and Norway. Our definitions of ‘high school’ and ‘college’ bring the U.S. and Danish system closer, both qualitatively and in population means. However, this simplification of the Danish educational ladder reduces comparability to other Scandinavian schooling systems, unless similar simplifications are made there as well. Figure A52 in the data section of the Web Appendix illustrates how the two schooling outcomes are affected by our definitions and age restrictions in Denmark.
problematic issues are social promotion[^41] and the minimum school leaving age[^42] which may distort the levels of human capital associated with equal levels of schooling in Denmark and the U.S.

**Measuring skills.** For the U.S., we use the Peabody Individual Achievement Test (PIAT) scores to measure cognitive skills. The CNLSY features three sets of PIAT scores: reading recognition, reading comprehension, and math. For non-cognitive skills we use the antisocial, headstrong, hyperactivity subscales from the Behavior Problem Index (BPI). The measures of cognitive skills and non-cognitive skill are in accordance with those of, e.g., Cunha and Heckman (2008) and Heckman et al. (2006).

For Denmark, we measure skills using grades from the 9th grade. Cognitive skills measured are residualized by non-cognitive measures. Exam grades (even cognitive ones) are highly dependent on non-cognitive skills (the final year of compulsory schooling, i.e., before they begin high school). We measure cognitive skills using final math exam grades (written), math midterm grades (written), final physics exam grades, and non-cognitive skills using orderliness/organization/neatness grades from the Danish written exam, Danish written midterm, and

[^41]: Social promotion reduces the academic material needed to pass this level. Social promotion may, in a more complex form, result in reducing the academic levels needed to complete a given education, and thus, inflate graduation rates, invalidating cross-country comparisons of the educational levels in question. The phenomenon exists in both countries, evidenced by the substantial attention it has received in the public debate (for Denmark, see Berlingske Tidende 2015, Politiken 2014, and Produktivitetskommissionen (Productivity Commission) 2014 for examples of a discussion from the public debate. For the U.S., see McCombs et al. 2009, President Clinton 1998, and United States Department of Education 1999). There are, however, no data available that allows us to test for differences and/or similarities between social promotion in Denmark and the U.S.

[^42]: In the U.S., the law dictates that children should attend school until they turn 16–18 (depending upon state). For most states this includes the first year of high school. In Denmark, there is no minimum school-leaving age, but instead a minimum number of years of schooling. Children are not allowed to leave school before they have completed ninth grade. As a consequence, most U.S. children have to begin high school even though they are not forced to complete it. This may induce some to graduate high school who would not have done so in the Danish setting, and thus increase (perceived) educational mobility in the U.S.
and math written exam. As test scores and grades are highly associated with non-cognitive skills (Borghans et al., 2011a,b), we use residuals from the cognitive measures regressed on the non-cognitive measures in the measurement system to estimate cognitive skills.

3.2 Unadjusted Education by Parental Resources

Figures A14a to A14d in the Web Appendix show children’s educational attainment measured by completion of high school or equivalent (Figures A14a–b) and enrollment into college or equivalent (Figures A14c–d) by the log of parental wage income and wealth in the U.S. and Denmark.

Figures A14a and A14b show that, in both countries, rates of high school completion increase in parental income and wealth. In the U.S. data, the relationship has its greatest curvature at low levels of income and wealth, while a gradient is evident across the entire range of parental wealth and income in the Danish data. In both countries, 90% of children at the top of the income and wealth distribution complete high school, whereas for low levels of income and wealth, approximately 65–70% complete high school in the two countries. Broadening the income and wealth ranges to all levels of support beyond the ranges where we have an overlap between the two countries, Figure A15 in the Web Appendix shows that individuals whose parents are in the lower end of the distributions are more likely to complete high school in the

43Our measures of non-cognitive skills in the two countries are clearly not equivalent. The Danish measure of non-cognitive skills are more related to an orderliness/effort measure while the U.S. measure is related to behavioral problems. Another concern when using grades is that our measures of non-cognitive skills are closer related to academic achievement than to socio-emotional skills. We do not consider this an issue in the present case. When we estimate factor loadings and perform variance decompositions from the two factors on outcomes DUI and psychiatric admissions, these outcomes are significantly more associated with non-cognitive (socio-emotional) skills than cognitive skills. The factor for non-cognitive skills explains around three to five times as much of the variance in DUI and mental disorders compared to the factor for cognitive skills.

44Web Appendix Figures A16a–A16d show the corresponding results for quantiles of parental income and wealth. The overall pattern and conclusions are unchanged, although gradients do change as a result of the distributional differences between income/wealth in Denmark and the U.S.
U.S. than in Denmark. For parents with low levels of income and wealth, 60% and 45% of children in the U.S. and Denmark, respectively, complete high school.

Figures A14c and A14d show that college attendance rates also increase with parental wealth and income. The gradient, with respect to wealth, is larger in the U.S. than in Denmark at the bottom of the wealth distribution. Parental income is only strongly associated with increasing rates of college attendance for families with above-median wealth in the U.S. In contrast, in Denmark, the income gradient is largest for families with below-median wealth.

Finally, Figures A19a and A19b in the Web Appendix show level differences of the surfaces displayed in the previous figures for the areas of income and wealth where we have common support in the Danish and U.S. data. The figures show that levels of high school completion are higher in the U.S. than in Denmark for children from low-income/low-wealth families, while this group’s college attendance rates are substantially higher in Denmark than in the U.S.

The figures described above illustrate that levels of social mobility in Denmark do not always exceed social mobility in the U.S. One result in Figure A14 may suggest that mobility is higher in Denmark while another suggests the opposite. We next investigate which mediating factors explain mobility (or lack thereof) in Denmark and the U.S., and whether the role of these factors differ.

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45 Figures A17 and A18 in the Web Appendix show rates of high school completion and college attendance by wage income and wage income plus public benefits in levels and ranks, respectively. The figures show that there is little or no difference in the relationship between the two income measures for both levels of schooling in the U.S. and for college attendance in Denmark. For rates of high school completion in Denmark, however, we see that the inclusion of public benefits results in a steeper negative slope at the very lowest levels of incomes. The reason for this anomaly is that a small share of those with close to zero wage earnings and public transfers in Denmark live from capital income or profits from businesses instead. The educational outcomes of this group are very different from those experienced by children from the remaining low-income families.
3.3 Controlling for Skills Formed in Early Adolescence, Family Characteristics, and Sorting of Children into Schools by Parental Income

This section adjusts the figures displayed previously in this section by controlling for cognitive and non-cognitive skills, measures of family background, and measures of school characteristics. Doing so significantly reduces the income and wealth differentials, with early adolescent measures of cognitive and non-cognitive skills playing a major role.

Table 4 presents linear regression estimates of parental log income and wealth on children’s high school completion and college attendance for the U.S. and Denmark. The estimates can thus be interpreted as elasticities. In the upper panel of the table we present estimates with high school completion as the outcome, and in the lower part of the table we present the result with college attendance as the outcome. Below each set of estimates for Denmark and the U.S., we show differences in coefficients between the two countries and the associated p-values for tests of differences. The first column of the table shows the unadjusted linear estimates corresponding to Figure A14, and in the subsequent three columns we gradually increase the conditioning set.

From column 1 of the table, we see that parental income and wealth are strongly associated with children’s high school completion and college attendance in the U.S. and in Denmark. As shown in Figure A14, parental income and wealth gradients for children’s high school completion are significantly higher in Denmark, while only the gradient for wealth differs for college attendance.

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Web Appendix Table A16 shows the corresponding regression coefficients for parental income and wealth ranks for children’s high school completion and college attendance for child skills at age 15, family background, and school quality.
The second column presents the associations while controlling for child’s level of cognitive and non-cognitive skills measured at age 15–16. In comparison to the estimates from the first column, the income and wealth gradients for high school completion and college attendance are substantially reduced. Thus, the relationship between parental resources and child education is to a large degree mediated by levels of cognitive and non-cognitive skills at earlier ages. While the upper panel shows that the coefficients for income and wealth still differ between Denmark and the U.S. for high school completion, the estimates in the second column of the lower panel show that there are no significant differences between Denmark and the U.S. for either income or wealth gradients in college attendance.

Even though cognitive and non-cognitive skills are highly predictive of educational attainment in both Denmark and the U.S., cross-country differences in these skills do not explain the entire relationship between parental resources and educational attainment. When we extend the analysis in the third column by adding measures of parental background (education/family status) to the measures of child skills, the relationship between parental financial resources and child education weakens further.\textsuperscript{47} Again, we find that associations between parental income and wealth on the one hand and children’s probability of high school completion on the other, is stronger in Denmark compared to the U.S. We find no cross-country differences in the estimated relationships for college attendance.

Cognitive and non-cognitive skills and parental/family background play similar roles in mediating the relationship between parental financial resources and children’s educational outcomes in both countries. However, other differences remain in comparing educational income and wealth gradients in the two countries. For example, Denmark and the U.S. differ in the variability of school quality. Differences between the quality of public and private schooling

\textsuperscript{47}Parental background variables are: child gender (0/1), immigrant/minority (0/1), urban region (0/1), number of siblings, mother’s age at birth, and mother’s years of schooling.
likely depend on overall resources devoted to public schools—a major difference between the two countries. Denmark spends a far greater fraction of its GDP on public education than the U.S. Yet school resources and peer characteristics still vary by parental resources in Denmark, suggesting similar relationships between measures of schooling quality and family characteristics across the two countries. We present a preliminary exploration of these relationships for Denmark in this section, where we establish that a school quality gradient also exists in Denmark. However, due to lack of data, we are unable to test for differences in the distributions of school quality.

In the final column of Table 4, we show estimates of the association between children’s education and parental income and wealth conditioning on the child’s level of skills at ages 15–16, family background measures, and school characteristics measured in the primary school years. The gradients in parental income and wealth are substantially reduced because quality measures for primary school predict later educational attainment. For Denmark, there is no remaining significant relationship between parental resources and children’s education, while for the U.S., a small relationship remains. Moreover, we only find one statistically significant cross-country difference at a 5% level between the gradients of children’s rates of high school completion and college attendance as functions of parental financial resources, and generally none of the estimates differ qualitatively between Denmark and the U.S.

48 See Organisation for Economic Co-operation and Development (2014) for an overview of public and private resources devoted to primary, secondary, and tertiary education, and Table A13 in the Web Appendix.

49 As data sources from the two countries differ (Denmark is register data and U.S. is survey data), we proxy school characteristics by aspects that are not directly comparable. For the U.S., we use parents’ ratings of their child’s school and for Denmark, we use average characteristics of earlier cohorts in a given school. The results are used to illustrate that substantial sorting takes place in both Denmark and the U.S. and that this sorting coincides with parental resources. Hence, once we also condition on our school characteristics measures, the income and wealth gradients in children’s schooling are reduced further. Importantly, the results are not causal, nor do they identify the impact of school quality on later education.
### Table 4: Regression coefficients for high school completion and college attendance on parental resources by different conditioning sets

<table>
<thead>
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<td><strong>U.S., High school completion</strong></td>
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<td></td>
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<tr>
<td>Parental permanent wage income age 3–15</td>
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<td>0.023**</td>
<td>0.017**</td>
<td>0.006</td>
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<td>(0.008)</td>
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<td>0.018***</td>
<td>0.015***</td>
<td>0.012***</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.003)</td>
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<tr>
<td><strong>Denmark, High school completion</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parental permanent wage income age 3–15</td>
<td>0.066***</td>
<td>0.050***</td>
<td>0.045***</td>
<td>0.002</td>
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<td></td>
<td>(0.003)</td>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.002)</td>
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<tr>
<td>Parental wealth (net assets) age 15</td>
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<td>0.025***</td>
<td>0.023***</td>
<td>0.002</td>
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<tr>
<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
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<tr>
<td><strong>Difference in slope: U.S.-Denmark</strong></td>
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<tr>
<td>Δ Parental permanent wage income age 3–15</td>
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<td>-0.027</td>
<td>-0.028</td>
<td>0.004</td>
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<td>-0.007</td>
<td>-0.008</td>
<td>0.010</td>
</tr>
<tr>
<td>p-value</td>
<td>&lt;0.001</td>
<td>0.027</td>
<td>0.001</td>
<td>0.002</td>
</tr>
</tbody>
</table>

| **U.S., College attendance** |          |         |         |         |
| Parental permanent wage income age 3–15 | 0.063*** | 0.041*** | 0.035*** | 0.019** |
|                       | (0.010) | (0.010) | (0.010) | (0.009) |
| Parental wealth (net assets) age 15 | 0.022*** | 0.019*** | 0.010** | 0.008** |
|                       | (0.003) | (0.004) | (0.004) | (0.003) |
| **Denmark, College attendance** |          |         |         |         |
| Parental permanent wage income age 3–15 | 0.061*** | 0.043*** | 0.037*** | 0.011** |
|                       | (0.003) | (0.003) | (0.003) | (0.003) |
| Parental wealth (net assets) age 15 | 0.034*** | 0.018*** | 0.015*** | 0.001   |
|                       | (0.001) | (0.001) | (0.001) | (0.001) |
| **Difference in slope: U.S.-Denmark** |          |         |         |         |
| Δ Parental permanent wage income age 3–15 | 0.002   | -0.002  | -0.002  | 0.008   |
| p-value               | 0.848   | 0.774   | 0.848   | 0.400   |
| Δ Parental wealth (net assets) age | -0.012 | 0.001   | -0.005  | 0.007   |
| p-value               | <0.001  | 0.998   | 0.134   | 0.058   |
| **Residuating by:** |         |         |         |         |
| θC, θNC               | X       | X       | X       |         |
| Family background     | X       | X       |         |         |
| School characteristics |         |         |         | X       |

**Note:** Table shows regression coefficients of parental permanent wage income and wealth on children’s high school completion and college attendance for increasing conditioning set with skills, family background, and school characteristics. Table constructed using data from the CNLSY for the U.S./administrative register data on the full cohort born in 1987 for Denmark. The table shows p-values from tests of equal slope-coefficients against a two-sided alternative. Family background variables: child gender (0/1), immigrant/minority (0/1), urban region (0/1), siblings, mother’s age at birth, and mother’s years of schooling. School characteristics for U.S. include: grade for how teachers care about students, grade for whether school is considered safe, a dummy for whether child feels peer pressure to work hard, a dummy for whether child feels peer pressure to skip school, a dummy for whether child has received sex education in school, and a dummy for whether child attends private school. School characteristics for Denmark include: for each school, the means of previous cohort’s mother’s age at birth, mother’s high school completion, and mother’s college attendance, high school completion, and college attendance. Observations: U.S. 3,268; Denmark 39,539.

‡: p<0.1, *: p<0.05, **: p<0.01, ***: p<0.001.
3.4 Nonlinear Elasticities Between Children’s Education and Parents’ Income

The results reported in Table 4 are average estimates for the two populations in question. As we argued for income mobility, it is likely that any benefits from the Scandinavian welfare states accrue to the least advantaged. To allow for nonlinearities in the association between children’s education and parent’s gross income including transfers we repeat the analysis from Section 2.4 and estimate local linear regressions of children’s high school completion, college graduation on parents’ log income. Using the same data and estimation strategy as was used in Section 2 Figures 7a, b, d, and e examine the nonlinearities in the elasticities between children’s high school/college completion and parental gross income including transfers. Figures 7c and 7f show the cross-country differences between the estimated elasticities.\footnote{Figure A21 in the Web Appendix shows the equivalent results using wage earnings and not gross income including transfers. Figures A22–A23 show nonlinear estimates of children's education (high school completion, college graduation, master degree, highest grade completed) on parents' average highest grade completed. The figures show nonlinearities across different levels of parental education and differences between the various measures of children’s education. However, the figures show no patterns that favor educational mobility in Denmark over that in the U.S.}

The figures show strong nonlinearities within countries and across educational levels. Elasticities for high school completion vary between 0 and 0.3 in Denmark, and 0 and 0.12 in the U.S. For college graduation, the nonlinear relationship with parental income is even more apparent. In both countries, elasticities vary between approximately 0.10–0.15 for low-income families and 0.40–0.45 for families with an average annual income of around $125,000. Yet, as shown in Figures 7c and 7f, there is not any substantial difference in educational mobility between Denmark and the U.S. When differences arise, they often do not favor Denmark. Moreover, the shape of the cross-country differences in educational mobility across parents’ total gross income do not show any strong nonlinear pattern favoring the least advantaged in Denmark relative to the least advantaged in the U.S.
Figure 7: Local Intergenerational Elasticities between children’s education and parental log gross income including transfers, absolute income weights, Denmark and the U.S.

(a) High school completion, Denmark

(b) High school completion, U.S.

(c) High school completion, U.S.-Denmark difference

(d) College completion, Denmark

(e) College completion, U.S.

(f) College completion, U.S.-Denmark difference

Note: Figures 7a, b, d, and e show local linear regression slopes of children’s education (high school completion, college graduation) on log of parental gross income including transfers for Denmark and the U.S. Figures 7c and f show U.S.-Denmark difference in local Intergenerational Elasticities between children’s education and parental log gross income including transfers. High school completion is defined as highest completed grade $\geq 12$, college graduation as highest completed grade $\geq 15$. LLRs are weighted using kernels of absolute income. Standard errors constructed from 50 and 1,000 bootstraps, respectively. The vertical lines mark the 5th and 95th percentiles in the data.
These results also shed light on the likely relationship between credit constraints in the adolescent years and educational attainment, which is investigated by a large body of literature.\textsuperscript{51} That literature is often inconclusive as it does not control for the other parental characteristics associated with income. A related strand of literature investigates the effects of tuition and restrictions to funding of education.\textsuperscript{52} Even though we do not explicitly address this issue, our results are consistent with the evidence that it is not income \textit{during the adolescent years} that matters, but investments as crystallized in cognitive and non-cognitive skills and longer term family background factors that drive these associations.\textsuperscript{53} Our analysis shows that most of the association between high school completion and parental resources, and around half of the association between college enrollment and parental resources, is accounted for by differences in children’s cognitive and non-cognitive skills and family background in early adolescence.\textsuperscript{54} Although the U.S. and Denmark constitute two opposite poles in terms of tuition costs, the income and wealth gradients in high school completion and college enrollment do not differ substantially between the two countries.

In conclusion, despite the higher cognitive scores for the disadvantaged and the lower pecuniary costs of education in Denmark, our analysis in this section together with several other supplementary data sources (see Web Appendix Sections A.2 and B.4, Organisation for Economic Co-operation and Development 2014; Hertz et al. 2008) all point in the same direction. There are only few noteworthy differences in educational mobility between the U.S. and Denmark, and certainly nothing that can explain the differences in income and wage earnings mobility reported in Section 2. This analysis raises an important question: Are

\textsuperscript{51}See the summary of the literature in Heckman and Mosso (2014) and Lochner and Monge-Naranjo (2016).

\textsuperscript{52}Cameron and Taber (2004), Carneiro and Heckman (2002), and Keane and Wolpin (2001) find little evidence of this relationship as opposed to Bailey and Dynarski (2011), Belley and Lochner (2007), and Lochner and Monge-Naranjo (2012), who report stronger evidence of credit constraints to, for example, college enrollment.

\textsuperscript{53}This is consistent with the evidence reported in Cameron and Heckman (2001).

\textsuperscript{54}This finding mirrors the analysis of Heckman (2011) in showing the importance of cognitive and non-cognitive skills in explaining minority-majority differences in college attainment in the U.S.
there factors embedded in the Scandinavian welfare state which reduce incentives to pursue education and thus educational mobility? We will discuss and investigate this in the next subsection.

3.5 Welfare Levels and Educational Incentives

It is well established that the economic returns to education are substantially lower in Denmark and the other Scandinavian countries than in the U.S. (see, e.g., Fredriksson and Topel (2010), Harmon et al. (2003). Two mechanisms leading to this difference are wage compression and the high levels of welfare benefits observed in Scandinavia. As noted in Edin and Topel (1997) and Fredriksson and Topel (2010), incentives to pursue education diminish as returns to education decrease and welfare benefits increase. In this subsection we establish an empirical relationship between educational attainment and potential public benefits in Denmark. We refer the reader to Web Appendix Section B and Edin and Topel (1997), Fredriksson and Topel (2010), Freeman et al. (2010), Rosen (1997), and Tranæs (2006) for discussions and descriptive evidence of the differences between the income and employment prospects of un- or low-skilled individuals in Denmark and the U.S., and the relationship between public sector employment, public benefits, and the wage floor in Denmark. In Web Appendix Section B we further show that incomes are compressed in the tails of the educational and income distributions in Denmark. Hence, the lower returns to education in Denmark compared to the U.S. do not stem from cross-country differences in educational tracks which could cloud the relationship between years of schooling and income.

Figure 8 illustrates the issue at hand. The figure shows mean pre-tax wage earnings measured in 2010–2012 for the cohorts born 1973–1975 in Denmark, by highest completed educa-
tion together with horizontal lines indicating the 2011 maximum unemployment insurance benefits and the social assistance levels in Denmark. From the figure it is evident that for individuals with the lowest levels of education, average wage earnings barely exceed maximum social assistance levels. Even as one climbs the educational ladder, it is not until college completion that wage earnings are twice the size of social assistance. The progressivity of the Danish tax system only makes this pattern more pronounced.

While the relationship between returns to education, public benefits, and educational attainment has been discussed in the literature we cite, there is little causal evidence. Figure 9 provides the first evidence of such a causal relationship by illustrating the response to two reforms of social assistance levels for youths passed in Denmark in 1991 and 1992/1993, respectively, that increased the incentive to be enrolled in an education relative to dropping out. The first reform raised the minimum age of eligibility for full social assistance from age 20 to age 21 and the second reform raised the minimum age for receipt from 21 to 25. Below the minimum age, individuals are only entitled to ‘youth assistance’ (ungdomsydelse), which is approximately 50% of the full SA level and equal to the public education grant (SU).

Figure 9 shows rates of enrollment in any education measured on a weekly basis from age 19 to age 26 for the cohorts born in 1969–1974. In Figure 9a, we plot enrollment rates for individuals who were 20 and 21 years old at the timing of the 1991 reform that raised the minimum age from 20 to 21. The figure shows that enrollment rates were similar at younger ages.

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55 In this analysis we use the data which was introduced in Section 2.1.
57 Jonassen (2013) studies behavioral responses around age 25. He finds that take-up of social assistance increases substantially once benefits increase to full level at age 25. Furthermore, he finds no evidence of substitution between social assistance and public education grant at age 25. This contrast to our results suggests that the link between social assistance and education is mainly present at lower-tier educations (i.e., for low-skilled individuals) which would have been completed at age 25 in any case.
ages, but at the exact timing of the reform the two groups diverged and enrollment rates became approximately 2–3%-points higher for the affected group who were 20 years old at the timing of the reform, relative to the unaffected group who were 21 years old.

Figure 9b shows a similar response around the timing of the 1992/1993 reform that raised the minimum age from age 21 to 25. The figure shows enrollment rates for individuals who were 20–23 years old at the timing of the reform. We see that the groups had similar trajectories prior to the change but diverged once the minimum age was raised. Those affected at age 20 broke away from the three remaining cohorts at age 20. Those affected at age 21 broke away from the two remaining cohorts at age 21. Those affected at age 22 diverged at this exact age from those who were affected at age 23.

The results presented here establish a negative relationship between educational enrollment and the level of public benefits, albeit with two caveats. First, it is beyond the scope of this paper to estimate the underlying behavioral parameters—we strongly encourage future research to explore this relationship further. Second, we neither have precise estimates of the potential gains from the greater equality in childhood investments and fewer pecuniary costs of education in Denmark than in the U.S., nor the disincentives for educational attainment that wage compression and public benefits constitute. Hence, we cannot determine whether the similarities in educational mobility in the two countries occur because the effects offset each other, though we find this to be a plausible explanation given the evidence at hand.
Figure 8: Average wage earnings and potential benefits levels, cohorts 1973–1975 in 2010–2012, Denmark

Note: Figure shows average wage earnings per year from 2010 to 2012 for the cohorts born in 1973–1975 in Denmark. The figure also shows maximum unemployment insurance benefits, social assistance level for individuals with children (extra benefit for second child applies), and social assistance level for individuals without children. The horizontal lines are the raw benefits and do not include means tested daycare slots and other types of benefits. Average wage earnings are estimated from the full sample and are not conditional on employment.

Education: ‘Below high school’ is years of schooling < 12. Gymnasium is defined as 12 years of schooling and a gymnasium or HF degree (see discussion of HF in footnote 39). ‘Vocational/Some college’ is defined as 12 < years of schooling < 15, or 12 ≤ years of schooling < 15 and a vocational training degree. ‘College’ is defined as 15 ≤ years of schooling < 17. ‘Master or above’ is defined as years of schooling ≥ 17 which corresponds to at least a masters degree from a university.

Wage earnings: Taxable wage earnings and fringes, labor portion of business income, and non-taxable earnings, severance pay, and stock-options.

Unemployment insurance benefits: Eligibility is based on previous employment and membership of unemployment insurance fund (insurance is tax-deductable and benefits are subsidized by the public sector). The figure reports the maximum level available. Below this level, unemployment insurance benefits replace wage earnings by a rate of 90%.

Social assistance: Means tested (on household level) such that income earned is deducted 1:1 from benefits. Levels differ by whether recipients have children or not.
Figure 9: Fraction enrolled in education by age around the timing of two reforms in 1991 and 1992/1993 that raised the minimum age for eligibility for full social assistance levels, Denmark

(a) 1991 reform, minimum age raised from age 20 to 21  
(b) 1992/1993 reform, minimum age raised from age 21 to 25

Note: Figures show the fraction enrolled in an education by age (measured weekly) from age 19 until age 26 for the cohorts born in 1969 and 1970, and between 1971 and 1974, respectively. The figures are constructed using full population register data with exact enrollment and exit dates from all educational levels (except 1st–7th grade) in Denmark merged with demographic registers with exact information of birth dates. Both figures show enrollment rates around reforms where the minimum age for full social assistance eligibility was raised. In 1991 it was raised from age 20 to age 21. In 1992/1993 it was raised further from age 21 to age 25. Below this age of eligibility, the level of social assistance is approximately equal to that of the public education grant (50% of the full level of social assistance) which all students in Denmark are eligible to receive. Figure 9a shows enrollment rates for individuals who were 20 and 21 when the age for full social assistance eligibility was raised from 20 to 21. Figure 9b shows enrollment rates for individuals who were between 20 and 23 when the age for full social assistance eligibility was raised from 21 to 25.
3.6 Neighborhood Sorting of Children by Family Background

Neighborhood sorting by family socioeconomic status is prevalent in each country. Public schooling in Denmark is universal and attempts to offer all children equal amounts of high quality schooling. This policy may be disequalizing because children with early advantages accumulate skills at a higher rate while in school. High levels of equal investments in schooling for all children amplify initial gaps between advantaged and disadvantaged children. This is a consequence of static complementarity between investments and child skill levels at each age, reinforced by increasing complementarity between investments and skill levels as children age.

Figures 10 and 11 show that, in Denmark, different measures of parental resources correlate with the school and peer quality of public schools and thus, investments in children through the public schools tend to increase with parental income.

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58 Heckman and Mosso (2014) present evidence supporting disequalization.
59 Cunha and Heckman (2007), Carneiro et al. (2013), and Heckman and Mosso (2014) discuss static and dynamic complementarity. Static complementarity is described by the “Matthew Effect:” To those who have, more is given. Dynamic complementarity is the effect of investments at one age on building complementarity at later ages.
60 Danish schools receive higher rates per student for special needs education, but not based on overall resource level of catchment area. See the Public School Law.
61 A vast literature has described the significant impacts of school and peer quality on educational outcomes and income. See Sacerdote (2011) for examples.
Figure 10: Peers’ skill levels across parental income rank, Denmark

(a) Mean of birth endowments for peers in preschool

(b) Mean of cog. skills at ages 15–16 for peers in lower secondary school

(c) Mean of noncog. skills at ages 15–16 for peers in lower secondary school

Note: Figure shows school ‘leave-one-out’ means of predicted cognitive and non-cognitive skills, from the estimated measurement system, using the cohort born in 1987 in Denmark. Mean of peers’ birth endowments in preschool are calculated using the 1995 birth cohort. The skills are anchored to P(high school completion) and the y-axis may be interpreted as such. Hence, a difference of 0.02 from the log(income) of 10 to log(income) of 11 for non-cognitive skills implies that the mean level difference in non-cognitive skills for peers of children whose parents’ log(income) equal 10 and 11, respectively, are associated with a 2%-point difference to the likelihood of completing high school. We use birth weight, gestational length, and length at birth to estimate birth endowments. We use exam grades on math and physics to estimate cognitive skills and grades on organization/neatness to estimate non-cognitive skills.
Figure 11: Peers’ skill levels across property value in catchment area of lower secondary school, Denmark

(a) Mean of birth endowments for peers

(b) Mean of cognitive skills at ages 15–16 for peers

(c) Mean of non-cognitive skills at ages 15–16 for peers

Note: Figure shows school ‘leave-one-out’ means of predicted birth endowments and cognitive and non-cognitive skills, from the estimated measurement system, using the cohort born in 1987 in Denmark. The skills are anchored to P(high school completion) and the y-axis may be interpreted as such. Property value is measured as mean valuation of owned property (from Statistics Denmark and Danish national tax authorities) in a given catchment area. Hence, a difference of 0.02 from the 1st to the 100th percentile for cognitive skills implies that the mean level of cognitive skills for peers of children whose parents own property in the most expensive school catchment area are associated with a 2%-point higher likelihood of completing high school. We use birth weight, gestational length, and length at birth to estimate birth endowments. We use exam grades on math and physics to estimate cognitive skills and grades on organization/neatness to estimate non-cognitive skills.
In a similar vein, Figures 12a and b show variation in average high school completion and college attendance rates across schools. In some schools, only 50% of students complete high school and 10% of students attend college, respectively, while in other schools, all students complete high school and 80% attend college. The figures also show large differences in average parental gross income across schools. The differences correlate strongly with the later educational attainment of students. Figures 12c and d plot the average high school completion and college attendance rates against the school mean peer parental gross income and highest grade completed. The figures show that the average educational attainment of a 9th grade student is strongly positively correlated with peer family income and education.

Catchment areas for public institutions that limit peers to sort with certain income groups and equal public investments tend to favor children from high income families. The strong relationship in Denmark between educational attainment and family background could arise solely as a result of neighborhood sorting on the basis of family income and wealth.

We lack comparable information for the U.S. If in fact sorting is equally strong in the two countries, this factor may be an important contributor to explaining the near equality of educational IGES in both countries. Residential sorting may help undo the benefits of the Scandinavian welfare state. We leave this topic for future research.

Certainly equality of opportunity is not present in Denmark. Figure 13 shows socio-emotional ratings measured at age 7 and 12, and cognitive and language test scores measured at age 12 by parental permanent gross income for Danish children. For all three measures, the average gaps between the most disadvantaged children and the most advantaged children are around 0.5 of a standard deviation. Thus, as evidenced by the figure and our analysis earlier in this section, substantial skill gaps throughout childhood and adolescence remain in Den-

\[62\text{See Black and Machin (2011) for a review of this literature. Tiebout (1956) and Black (1999) shows that housing prices are affected by school quality. More related to the Danish case, Machin and Salvanes (2016) provide recent evidence on this issue from Norway.}\]
mark. While the Scandinavian welfare state invests heavily in children throughout childhood and redistributes income (consumption) during adulthood, it has not eradicated the strong influence of parents and early childhood conditions. As a consequence of the complementarity between skills and investments, later life universal schooling investments during childhood or adolescence may be ineffective in reducing gaps between advantaged and disadvantaged children.

4 Limitations, Future Directions, and Open Questions

Before concluding, we discuss some limitations of this study. First, like much of the empirical literature on social mobility, we report empirical relationships across generations. Our discussion emphasizes the need for a clearer theoretical framework to disentangle the effects of different income sources (wage earnings, profits, capital, public transfers, and taxation) and mechanisms through which they are related across generations (the dynamics of parental and public investments/human, monetary, and physical capital transmission).

Second, our analysis measures parental income as permanent income during a child’s primary and secondary schooling ages. Permanent family income over the life cycle of children has been shown to account for most of the variation in the relationship between family income and children’s schooling (Carneiro and Heckman 2002). Yet it may be that the pivotal differ-
ences between the U.S. and Denmark materialize at early ages. Low-income parents may be constrained in making early lifetime investments in the U.S. but not in Denmark.

Third, any attempt to capture a country’s level of intergenerational mobility and the relationship between parental and child outcomes by a few point estimates is bound to be unsatisfactory. While the estimation of nonlinear IGEs is a step in the right direction, other empirical strategies might be used. One strategy estimates local rank-regressions, where the IGE is found by minimizing the product of ranked residuals, thus putting less weight on extreme observations and more weight on mid-rank observations. Our empirical analysis of rank-regressions is consistent with our analysis of nonlinear IGEs. There is curvature in the estimated relationships at the top and at the bottom of the income distribution. Another method is copulas, which may be particularly useful in the present case of describing the dependence between parental and children’s income because tail dependence in income distributions is notoriously difficult to determine.

There are a number of aspects of inequality that we have not analyzed. We have not addressed issues pertaining to in-kind transfers, health, and access to health care, but only to inequality in terms of skill formation, educational attainment, and income. A more comprehensive analysis would be desirable.

63 In a similar vein, in our analysis of income mobility, we have chosen an age range to measure income which should proxy lifetime income closely. Yet we still only provide a snapshot of income mobility under the assumption of homogenous time preferences. Educational attainment and time preference correlate. In consequence, intergenerational income mobility estimates reported here and in the remaining literature may be biased if income at older ages should receive less weight than income at early ages for individuals without college degrees and vice versa. One possible next step would be to create a Generalized Intergenerational Income Elasticity which evaluates the entire stream of lifetime earnings for parents and children, allowing for differential time preferences. Even better would be to form the value functions of lifetime earnings (see, e.g., Hai and Heckman 2016).

64 See the discussion in Lochner and Monge-Naranjo 2016.

65 See Section D of the Web Appendix for a brief outline.

66 See Section E of the Web Appendix for a brief introduction and examples.
5 Conclusion

Academics and policy makers around the world point with admiration to Scandinavia as a model for reducing inequality and promoting social mobility without sacrificing economic efficiency or growth. This paper takes a first step towards investigating in what dimensions and for what reasons Scandinavia is more effective in promoting social mobility.

Despite Denmark’s far more generous welfare state, its extensive system of preschools, and its free college tuition, the family influence/child education relationship is very similar to that of the U.S. In both countries, much of the average association between parental resources and the educational attainment of children can be explained by factors set in place by age 15, including child skills. However, distributions of cognitive test scores of disadvantaged Danish children are much better than those of their counterparts in the U.S.

The failure to promote greater educational mobility in spite of providing generous social services is most likely rooted in the welfare state. Our findings point to wage compression and the higher levels of welfare benefits as being counterproductive in providing incentives to pursue education. The low returns to education observed in Denmark, in particular at the lower levels of education, help explain the disconnect between the egalitarian childhood policies in Denmark and the roughly equal levels of educational mobility in Denmark and the U.S. The sorting of families into neighborhoods and schools by levels of parental advantage is likely another contributing factor. While the Danish welfare state may mitigate some childhood inequalities, substantial skill gaps still remain.

While patterns of educational attainment are similar across the two countries, the relationships linking skills and income differ greatly. The IGE estimates of income mobility—used as evidence for Scandinavia’s high social mobility—are very sensitive to the choice of income measure analyzed. Using total income potential excluding public transfers as a measure of income,
there are fewer differences between estimated IGEs for Denmark and the U.S. than previously portrayed. Considering wage earnings or wage earnings plus public transfers, average income mobility is higher in Denmark than in the U.S. We find evidence of strong nonlinearities in measures of intergenerational income mobility. Differences in Danish-U.S. income mobility favor Denmark (i.e., produce lower local IGEs) at higher levels of parental income and at very low levels of parental income. The education-family background gradients are also nonlinear in both countries but do not favor Denmark at either tail of the parental income distribution.

This paper sends a cautionary note to the many enthusiasts endorsing the Scandinavian welfare state. We make no statements about the optimality and fairness of the U.S. and Danish systems from a philosophical or social choice point of view. The Danish welfare state clearly boosts the cognitive test scores of disadvantaged children compared to their U.S. counterparts. But test scores are not the whole story, or even the main story of child success, despite the emphasis on them in popular discussions. Moreover, substantial gaps in test scores remain across social groups within Denmark.

Differences in income mobility between Denmark and the U.S. also arise from wage compression in the Danish labor market, the progressivity of the Danish tax-transfer system, and the increasing college premium in the U.S. and the rise in inequality there. These factors drive the higher population average income mobility in Denmark and equalize post-tax consumption possibilities. They also discourage educational attainment in Denmark. Along with neighborhood sorting, they explain the similarity in the influence of family background on educational attainment in the two countries.

The U.S. excels in incentivizing educational attainment. The Danish welfare state promotes cognitive skills for the disadvantaged children. Policies that combine the best features of each system would appear to have the greatest benefit for promoting intergenerational mobility in terms of both income and educational attainment.
References


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*LABOUR 14*(3), 523–546.


Sacerdote, B. (2011). Nature and nurture effects on children’s outcomes: What have we learned from studies of twins and adoptees? In J. Benhabib, A. Bisin, and M. O. Jackson (Eds.), *Handbook of Social Economics*, Volume 1A, Chapter 1, pp. 1–30. Amsterdam: Elsevier B. V.


Table 5: Summary of previous literature’s IGE estimates and income definitions for Denmark and the U.S. (Table continued on next page)

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Data Source</th>
<th>Child’s Income</th>
<th>Parental Income</th>
<th>Income definition</th>
<th>IGE estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Munk et al. (2016)</td>
<td>Denmark</td>
<td>Register data, Statistics Denmark</td>
<td>Log(Son’s earnings) measured in 2004–2008, age 7–14 in 1980</td>
<td>Log(Father’s earnings) measured in 1980–1984</td>
<td>Earnings definition not detailed in paper</td>
<td>0.171 (0.002)</td>
</tr>
<tr>
<td>Chetty et al. (2014)</td>
<td>U.S.</td>
<td>Federal income tax records</td>
<td>Log(Child’s family income) measured in 2011–2012, cohorts born in 1980–1982</td>
<td>Log(Parental family income) when children were 10, 16</td>
<td>Total pre-tax income at the household level from all sources, excluding nontaxable cash benefits</td>
<td>Sons: 0.349 (0.001) Daughters: 0.342 (0.001)</td>
</tr>
<tr>
<td>Blundon et al. (2014)</td>
<td>U.S.</td>
<td>PSID</td>
<td>Log(Son’s earnings) measured at ages 30–34</td>
<td>Log(Parental family income) measured when children were 10, 16</td>
<td>Child’s earnings, Parental income from all sources</td>
<td>0.385 (0.046)</td>
</tr>
<tr>
<td>Hussain et al. (2009)</td>
<td>Denmark</td>
<td>Register data, Statistics Denmark</td>
<td>Log(Son’s earnings) measured in 2002 at ages 30–40</td>
<td>Log(Father’s earnings) measured in 1984–1988 at ages 30–66</td>
<td>Wage rate multiplied by hours of work plus sickness pay and unemployment insurance benefits</td>
<td>0.136 (0.004)</td>
</tr>
<tr>
<td>Bratsberg et al. (2007)</td>
<td>Denmark</td>
<td>Register data, Statistics Denmark</td>
<td>Log(Son’s Earnings) measured in 1998 and 2000, cohort 1958</td>
<td>Log(Father’s earnings) measured in 1980–1981</td>
<td>Total earnings from all employers</td>
<td>0.121 (0.008)</td>
</tr>
<tr>
<td>Bratsberg et al. (2007)</td>
<td>U.S.</td>
<td>NLSY</td>
<td>Log(Son’s Earnings) measured in 1995 and 2001, cohort 1957–1964</td>
<td>Log(Parental earnings) measured in 1980–1981</td>
<td>Sum of mother’s and father’s earnings</td>
<td>0.151 (0.009)</td>
</tr>
<tr>
<td>Jantti et al. (2006)</td>
<td>Denmark</td>
<td>Register data, Statistics Denmark</td>
<td>Log(Child’s earnings) measured in 1998 and 2002, cohorts 1958–1960</td>
<td>Log(Father’s earnings) measured in 1980</td>
<td>Wages, salaries, and self-employment income</td>
<td>Sons: 0.071 [0.064, 0.079] Daughters: 0.034 [0.027, 0.041]</td>
</tr>
<tr>
<td>Jantti et al. (2006)</td>
<td>U.S.</td>
<td>NLSY</td>
<td>Log(Child’s earnings) measured in 1995 and 2001, cohorts 1957–1964</td>
<td>Log(Father’s earnings) measured in 1978</td>
<td>Family income from all sources</td>
<td>Sons: 0.517 [0.444, 0.590] Daughters: 0.283 [0.181, 0.385]</td>
</tr>
</tbody>
</table>

Note: Table summarizes results of the previous literature’s estimates of the intergenerational income elasticity for Denmark and the U.S. (selected studies only for the U.S.). The table summarizes the data sources used, income types compared, cohorts and ages at which income is measured, the income definitions used, and each paper’s main estimates (OLS log-log unless otherwise noted).
Table 5: (Continued) Summary of previous literature’s IGE estimates and income definitions for Denmark and the U.S.

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Data Source</th>
<th>Child’s Income</th>
<th>Parental Income</th>
<th>Income definition</th>
<th>IGE estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mazumder (2005)</td>
<td>U.S.</td>
<td>SIPP matched to SSA</td>
<td>Log(Child’s earnings) measured in 1995–1998 for sons born in 1963–1968</td>
<td>Log(Father’s earnings) measured in 1970–1985</td>
<td>Individual’s annual taxable earnings from Social Security Administration’s records</td>
<td>Sons: Tobit: 0.61 (0.096) Daughters: Tobit: 0.570 (0.159)</td>
</tr>
<tr>
<td>Bonke et al. (2005)</td>
<td>Denmark</td>
<td>Register data, Statistics Denmark</td>
<td>Log(Child’s earnings) measured in 2002, ages 30–40</td>
<td>Log(Parental earnings) measured in 1980–1984</td>
<td>Earnings defined as hourly age multiplied by annual hours worked</td>
<td>0.24 (0.096) controlling for father’s age</td>
</tr>
<tr>
<td>Eriksson et al. (2005)</td>
<td>Denmark</td>
<td>Register data, Statistics Denmark</td>
<td>Log(Child’s earnings) measured in 2001, cohort of 1954</td>
<td>Log(Father’s earnings) measured in 1968 or 1969</td>
<td>Earnings defined as wage income rounded to seven intervals for fathers and 11 intervals for children</td>
<td>Sons: 0.292 (0.077) Daughters: 0.210 (0.065) controlling for father’s age</td>
</tr>
<tr>
<td>Chadwick and Solon (2002)</td>
<td>U.S.</td>
<td>PSID</td>
<td>Log(Child’s family income) measured in 1991, born in 1951–1966</td>
<td>Log(Family income) measured in 1967–1971</td>
<td>Total taxable income from all sources for all family members</td>
<td>Sons: 0.535 (0.059) Daughters: 0.429 (0.063)</td>
</tr>
<tr>
<td>Bjorklund and Jäntti (1997)</td>
<td>U.S.</td>
<td>PSID</td>
<td>Log(Son’s earnings) measured in 1987, cohorts 1951–1959</td>
<td>Log(Father’s earnings) measured in 1967–1971</td>
<td>Total annual earnings from wages and salaries</td>
<td>IV: 0.516 (0.138) TSIIV: 0.52 (0.14)</td>
</tr>
<tr>
<td>Solon (1992)</td>
<td>U.S.</td>
<td>PSID</td>
<td>Log(Son’s earnings) measured in 1984, ages 25–33</td>
<td>Log(Father’s hourly wage) measured in 1967</td>
<td>The hourly wage a ratio of annual earnings to annual hours of work</td>
<td>0.415 (0.09)</td>
</tr>
<tr>
<td>Zimmer (1992)</td>
<td>U.S.</td>
<td>NLS</td>
<td>Log(Son’s earnings) measured in 1981, ages 29–39</td>
<td>Log(Father’s earnings) measured in 1965–1970</td>
<td>Total annual earnings from wages and salaries</td>
<td>0.54 (0.08)</td>
</tr>
</tbody>
</table>

Note: Table summarizes results of the previous literature’s estimates of the intergenerational income elasticity for Denmark and the U.S. (selected studies only for the U.S.). The table summarizes the data sources used, income types compared, cohorts and ages at which income is measured, the income definitions used, and each paper’s main estimates (OLS log-log unless otherwise noted).
Figure 12: High school completion and college attendance rates, variation across schools and parental characteristics

(a) Average high school completion rates and parental income across schools

(b) Average college attendance rates and parental gross income across schools

(c) High school completion and college attendance rates across average gross income of school peers’ parents

(d) High school completion and college attendance rates across average highest grade completed of school peers’ parents

Note: Figures 12a and b show distributions of average high school completion and college attendance rates within a school cohort (born in 1987) in the bars and scatterplots of the bin-means of parental gross income in grade 9. Figures 12c and d show average high school completion and college attendance rates across the mean levels of the income of peers’ (students born in 1987 and belonging to the same school and school cohort) parents. All four figures have been constructed using the Danish register data described in Section 3.1.
Figure 13: Test score gaps in Denmark at age 7 and age 12, by parental permanent gross income

(a) Socio-emotional difficulties (SDQ), age 7

(b) Socio-emotional difficulties (SDQ), age 12

(c) Cognitive test scores, age 12

(d) Language test scores, age 12

Note: Figure shows deviations of SDQ scores (in figures a and b), CHIPS scores (cognitive test in figure c), and a language test score (in figure d) relative to the sample mean by $4,000 bins of parental permanent gross income including transfers. Scores have been standardized to mean 0 and standard deviation 1. A higher score of SDQ implies greater socio-emotional difficulties. A higher score in the CHIPS and language test implies better cognitive and language skills. Figures have been constructed using Danish register data in combination with the Danish Longitudinal Study of Children (DALSC), see: http://gl.sfi.dk/Default.aspx?AreaID=21
Web Appendix for
Scandinavian Fantasy:
The Sources of Intergenerational Mobility in Denmark and the U.S.

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Rockwool Foundation Research Unit

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University of Chicago
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A Supplementary Tables and Estimation Results

A.1 Supplements to Section 2

Table A1: Income levels by deciles, Denmark and the U.S.

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<th>Quatile</th>
<th>5th</th>
<th>10th</th>
<th>20th</th>
<th>30th</th>
<th>40th</th>
<th>50th</th>
<th>60th</th>
<th>70th</th>
<th>80th</th>
<th>90th</th>
<th>95th</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual income</td>
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<td>Total gross income incl. public transfers</td>
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</tr>
<tr>
<td>Denmark</td>
<td>20,998</td>
<td>26,235</td>
<td>32,582</td>
<td>37,348</td>
<td>41,077</td>
<td>44,692</td>
<td>48,629</td>
<td>53,120</td>
<td>59,994</td>
<td>72,920</td>
<td>88,338</td>
</tr>
<tr>
<td>U.S.</td>
<td>2,213</td>
<td>7,450</td>
<td>14,482</td>
<td>20,145</td>
<td>27,491</td>
<td>34,273</td>
<td>43,620</td>
<td>53,116</td>
<td>68,280</td>
<td>93,884</td>
<td>122,228</td>
</tr>
<tr>
<td>Total gross income excl. public transfers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Denmark</td>
<td>83</td>
<td>7,928</td>
<td>25,252</td>
<td>33,064</td>
<td>37,890</td>
<td>42,137</td>
<td>46,464</td>
<td>51,378</td>
<td>58,428</td>
<td>71,775</td>
<td>87,378</td>
</tr>
<tr>
<td>U.S.</td>
<td>1,500</td>
<td>5,829</td>
<td>14,615</td>
<td>21,406</td>
<td>28,976</td>
<td>35,281</td>
<td>43,923</td>
<td>53,693</td>
<td>68,280</td>
<td>96,020</td>
<td>124,193</td>
</tr>
<tr>
<td>Net-of-tax income</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Denmark</td>
<td>16,593</td>
<td>20,612</td>
<td>25,702</td>
<td>30,446</td>
<td>35,662</td>
<td>39,729</td>
<td>43,402</td>
<td>47,261</td>
<td>51,721</td>
<td>57,877</td>
<td>69,846</td>
</tr>
<tr>
<td>U.S.</td>
<td>7,685</td>
<td>11,006</td>
<td>18,101</td>
<td>25,022</td>
<td>27,774</td>
<td>31,963</td>
<td>37,161</td>
<td>43,404</td>
<td>51,680</td>
<td>66,936</td>
<td>80,740</td>
</tr>
<tr>
<td>Wage earnings plus public transfers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Denmark</td>
<td>13,005</td>
<td>22,573</td>
<td>30,446</td>
<td>35,662</td>
<td>39,729</td>
<td>43,402</td>
<td>47,261</td>
<td>51,721</td>
<td>57,877</td>
<td>69,846</td>
<td>83,985</td>
</tr>
<tr>
<td>U.S.</td>
<td>5,034</td>
<td>9,475</td>
<td>15,053</td>
<td>21,448</td>
<td>29,228</td>
<td>35,034</td>
<td>43,879</td>
<td>51,971</td>
<td>67,805</td>
<td>93,641</td>
<td>122,382</td>
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<tr>
<td>Household income</td>
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</tr>
<tr>
<td>Total gross income incl. public transfers</td>
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</tr>
<tr>
<td>Denmark</td>
<td>26,814</td>
<td>34,317</td>
<td>47,876</td>
<td>63,531</td>
<td>76,066</td>
<td>84,231</td>
<td>92,270</td>
<td>101,342</td>
<td>112,937</td>
<td>133,814</td>
<td>157,002</td>
</tr>
<tr>
<td>Total gross income excl. public transfers</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Denmark</td>
<td>2,282</td>
<td>21,096</td>
<td>40,438</td>
<td>53,254</td>
<td>67,466</td>
<td>77,934</td>
<td>86,934</td>
<td>96,257</td>
<td>108,221</td>
<td>129,378</td>
<td>152,501</td>
</tr>
<tr>
<td>U.S.</td>
<td>7,081</td>
<td>17,090</td>
<td>29,448</td>
<td>41,653</td>
<td>53,329</td>
<td>65,267</td>
<td>78,744</td>
<td>96,202</td>
<td>118,338</td>
<td>155,561</td>
<td>194,539</td>
</tr>
<tr>
<td>Net-of-tax income</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
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</tr>
<tr>
<td>Denmark</td>
<td>20,860</td>
<td>26,868</td>
<td>36,643</td>
<td>48,426</td>
<td>58,080</td>
<td>64,166</td>
<td>69,561</td>
<td>75,368</td>
<td>82,438</td>
<td>94,561</td>
<td>108,039</td>
</tr>
<tr>
<td>U.S.</td>
<td>11,601</td>
<td>19,365</td>
<td>29,370</td>
<td>37,659</td>
<td>45,929</td>
<td>55,157</td>
<td>65,490</td>
<td>77,448</td>
<td>92,365</td>
<td>115,961</td>
<td>142,651</td>
</tr>
<tr>
<td>Household income per adult</td>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Total gross income incl. public transfers</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Denmark</td>
<td>23,900</td>
<td>28,519</td>
<td>34,942</td>
<td>39,081</td>
<td>42,321</td>
<td>45,597</td>
<td>49,138</td>
<td>53,349</td>
<td>59,187</td>
<td>69,893</td>
<td>82,124</td>
</tr>
<tr>
<td>U.S.</td>
<td>8,050</td>
<td>12,027</td>
<td>19,248</td>
<td>25,927</td>
<td>31,531</td>
<td>37,607</td>
<td>45,045</td>
<td>53,074</td>
<td>65,649</td>
<td>86,557</td>
<td>106,874</td>
</tr>
<tr>
<td>Total gross income excl. public transfers</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Denmark</td>
<td>1,967</td>
<td>15,539</td>
<td>28,195</td>
<td>34,887</td>
<td>39,117</td>
<td>42,847</td>
<td>46,618</td>
<td>51,055</td>
<td>56,912</td>
<td>67,780</td>
<td>79,912</td>
</tr>
<tr>
<td>U.S.</td>
<td>3,374</td>
<td>10,140</td>
<td>18,090</td>
<td>24,538</td>
<td>30,811</td>
<td>36,883</td>
<td>44,636</td>
<td>53,326</td>
<td>65,414</td>
<td>85,897</td>
<td>106,546</td>
</tr>
<tr>
<td>Net-of-tax income</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Denmark</td>
<td>18,547</td>
<td>22,304</td>
<td>27,073</td>
<td>30,023</td>
<td>32,372</td>
<td>34,570</td>
<td>36,841</td>
<td>39,448</td>
<td>42,924</td>
<td>49,072</td>
<td>56,187</td>
</tr>
<tr>
<td>U.S.</td>
<td>7,685</td>
<td>11,006</td>
<td>18,101</td>
<td>25,022</td>
<td>27,774</td>
<td>31,963</td>
<td>37,161</td>
<td>43,404</td>
<td>51,680</td>
<td>66,936</td>
<td>80,740</td>
</tr>
</tbody>
</table>

### Table A2: IGE estimates with different income measures, Denmark and the U.S., with equal year of birth distributions

<table>
<thead>
<tr>
<th>Gross income excl.</th>
<th>Gross income incl.</th>
<th>Wage earnings</th>
<th>Wage earnings and Net-of-tax total gross income</th>
</tr>
</thead>
<tbody>
<tr>
<td>public transfers</td>
<td>public transfers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(5)</td>
<td>(6)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(7)</td>
<td>(8)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(9)</td>
<td></td>
</tr>
<tr>
<td><strong>Denmark</strong></td>
<td><strong>U.S.</strong></td>
<td><strong>Denmark</strong></td>
<td><strong>U.S.</strong></td>
</tr>
</tbody>
</table>

**With same year of birth distribution**

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0.339***</td>
<td>0.312***</td>
<td>0.253***</td>
<td>0.446***</td>
</tr>
<tr>
<td>(0.008)</td>
<td>(0.055)</td>
<td>(0.006)</td>
<td>(0.054)</td>
</tr>
<tr>
<td>Observations</td>
<td>47,485</td>
<td>621</td>
<td>47,485</td>
</tr>
</tbody>
</table>

**With same number of observations per year and same year of birth distribution**

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0.308***</td>
<td>0.312***</td>
<td>0.246***</td>
<td>0.446***</td>
</tr>
<tr>
<td>(0.086)</td>
<td>(0.055)</td>
<td>(0.050)</td>
<td>(0.054)</td>
</tr>
<tr>
<td>Observations</td>
<td>621</td>
<td>621</td>
<td>621</td>
</tr>
</tbody>
</table>

**Note:** Table shows coefficients ($\beta_{IGE}$) and standard errors from regressions of child’s log income on parental log income for Denmark and the U.S. with similar year of birth distribution for Denmark as observed in the PSID data. For Denmark, we use full population register data for children born in 1972–1978 and for the U.S., we use PSID data for children born in 1972–1978. For Denmark, parental income is measured as a 9 year average from the child’s 7th to 15th year and the child’s income is measured as average in 2010–2012. For the U.S., parental income is measured as a 9 year average from the child’s 7th to 15th year and the child’s income is measured as last year income at ages 34–41, 33–40, 32–39, 31–38, 30–37, 30–36, and 30–35 for the 1972, 1973, 1974, 1975, 1976, 1977, and 1978 cohorts, respectively. Income variables otherwise defined as detailed in Table 1.
Figure A1: Income distributions, Denmark and the U.S. in 2011

(a) Wage earnings

(b) Net-of-tax (disposable) income

Note: Figure shows wage earnings and total net-of-tax income for Denmark and the U.S., for cohorts born 1973–1975. For Denmark, income is measured in 2011 using administrative register data. For the U.S., income is measured in 2011 using March CPS data. For the U.S. net-of-tax income, we report household income (individual income plus the income of a spouse if cohabiting or married) divided by number of adults in the household. The figures only include positive incomes.
Table A3: IGE estimates with different income measures, Denmark and the U.S., controlling for child’s highest completed grade

<table>
<thead>
<tr>
<th></th>
<th>Gross income excl. public transfers</th>
<th>Gross income incl. public transfers</th>
<th>Wage earnings</th>
<th>Wage earnings and public transfers</th>
<th>Net-of-tax total gross income</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
<tr>
<td>Denmark</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U.S.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \beta_{IGE} )</td>
<td>0.208***</td>
<td>0.181***</td>
<td>0.168***</td>
<td>0.302***</td>
<td>0.051***</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.044)</td>
<td>(0.003)</td>
<td>(0.056)</td>
<td>(0.003)</td>
</tr>
<tr>
<td>( \beta_{HCG} )</td>
<td>0.118***</td>
<td>0.149***</td>
<td>0.062***</td>
<td>0.123***</td>
<td>0.133***</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.012)</td>
<td>(0.001)</td>
<td>(0.018)</td>
<td>(0.001)</td>
</tr>
</tbody>
</table>

Observations

- Denmark: 149,190
- U.S.: 621
- Denmark: 149,190
- U.S.: 621
- Denmark: 149,190
- U.S.: 621
- Denmark: 149,190
- U.S.: 621

**Note:** Table shows coefficients (\( \beta_{IGE} \)) and highest completed grade, and the corresponding standard errors from regressions of child’s log income on parental log income and child’s highest completed grade for Denmark and the U.S. For Denmark, we use full population register data for children born in 1973–1975 and for the U.S., we use PSID data for children born in 1972–1978. For Denmark, parental income is measured as a 9 year average from the child’s 7th to 15th year and the child’s income is measured at ages 35–37, 36–38, and 37–39 for the 1975, 1974, and 1973 cohorts, respectively. For the U.S., parental income is measured as a 9 year average from the child’s 7th to 15th year and the child’s income is measured as last year income at ages 34–41, 33–40, 32–39, 31–38, 30–37, 30–36, and 30–35 for the 1972, 1973, 1974, 1975, 1976, 1977, and 1978 cohorts, respectively. Income variables defined as detailed in Table 1. IGE coefficients are estimated conditional on child’s highest completed grade.
Table A4: IGE estimates with different income measures, Denmark and the U.S., controlling for parents education

<table>
<thead>
<tr>
<th></th>
<th>Gross income excl. public transfers</th>
<th>Gross income incl. public transfers</th>
<th>Wage earnings</th>
<th>Wage earnings and public transfers</th>
<th>Net-of-tax total gross income</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
<tr>
<td>Denmark</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U.S.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\beta_{IGE}$</td>
<td>0.288***</td>
<td>0.193***</td>
<td>0.206***</td>
<td>0.300***</td>
<td>0.050***</td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
<td>(0.050)</td>
<td>(0.004)</td>
<td>(0.062)</td>
<td>(0.003)</td>
</tr>
<tr>
<td>Observations</td>
<td>149,190</td>
<td>621</td>
<td>149,190</td>
<td>621</td>
<td>149,190</td>
</tr>
</tbody>
</table>

Note: Table shows coefficients ($\beta_{IGE}$) and standard errors from regressions of child’s log income on parental log income for Denmark and the U.S. while controlling for average of parents’ education. For Denmark, we use full population register data for children born in 1973–1975 and for the U.S., we use PSID data for children born in 1972–1978. For Denmark, parental income is measured as a 9 year average from the child’s 7th to 15th year and the child’s income is measured at ages 35–37, 36–38, and 37–39 for the 1975, 1974, and 1973 cohorts, respectively. For the U.S., parental income is measured as a 9 year average from the child’s 7th to 15th year and the child’s income is measured as last year income at ages 34–41, 33–40, 32–39, 31–38, 30–37, 30–36, and 30–35 for the 1972, 1973, 1974, 1975, 1976, 1977, and 1978 cohorts, respectively. Income variables defined as detailed in Table 1. IGE coefficients are estimated conditional on the average of parents’ highest completed grade (replacing the average with mother’s highest completed grade if information for father is missing, and vice versa).
Table A5: IGE estimates with different income measures, Denmark and the U.S., including zeros

<table>
<thead>
<tr>
<th></th>
<th>Gross income excl. public transfers</th>
<th>Gross income incl. public transfers</th>
<th>Wage earnings</th>
<th>Wage earnings and public transfers</th>
<th>Net-of-tax total gross income</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U.S.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>β</strong>_{IGE}</td>
<td>0.491***</td>
<td>0.218***</td>
<td>0.290***</td>
<td>0.181***</td>
<td>0.208***</td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
<td>(0.036)</td>
<td>(0.003)</td>
<td>(0.034)</td>
<td>(0.003)</td>
</tr>
<tr>
<td>β_{Child,Parents} /sd(Child)</td>
<td>0.2461^{1.060} /0.025</td>
<td>0.2221^{1.255} /1.201</td>
<td>0.201^{0.491} /0.040</td>
<td>0.1971^{1.072} /1.156</td>
<td>0.1181^{1.208} /0.089</td>
</tr>
<tr>
<td></td>
<td>0.2111^{1.228} /1.245</td>
<td>0.0940^{0.730} /0.527</td>
<td>0.2041^{1.202} /1.195</td>
<td>0.1740^{0.446} /0.337</td>
<td>0.1181^{1.208} /1.245</td>
</tr>
<tr>
<td>Observations</td>
<td>166,359</td>
<td>702</td>
<td>166,359</td>
<td>702</td>
<td>166,359</td>
</tr>
</tbody>
</table>

**Note:** Table shows coefficients (β_{IGE}) and standard errors from regressions of child’s log income on parental log income for Denmark and the U.S. while imputing missing and zero incomes with $1,000. For Denmark, we use full population register data for children born in 1973–1975 and for the U.S., we use PSID data for children born in 1972–1978. For Denmark, parental income is measured as a 9 year average from the child’s 7th to 15th year and the child’s income is measured at ages 35–37, 36–38, and 37–39 for the 1975, 1974, and 1973 cohorts, respectively. For the U.S., parental income is measured as a 9 year average from the child’s 7th to 15th year and the child’s income is measured as last year income at ages 34–41, 33–40, 32–39, 31–38, 30–37, 30–36, and 30–35 for the 1972, 1973, 1974, 1975, 1976, 1977, and 1978 cohorts, respectively.

**Total gross income excl. public transfers =**
1. Denmark: All taxable income including wage earnings, profits from own business, capital income, and foreign income excluding all public transfers (both taxable and non-taxable).
2. U.S.: All taxable income including earnings (payroll income from all sources, farm income, and the labor portion of business income), asset income (such as rent income, dividends, interest, income from trust and royalties, and asset income from business), and private transfers (such as income from alimony, child support, and help from relatives and others).

**Total gross income incl. public transfers =**
3. Denmark: All taxable income including wage earnings, public transfers, profits from own business, capital income, and foreign income.
4. U.S.: All taxable income including earnings, asset income, private transfers, and public transfers (such as social security income, SSI, TANF, ETC, other welfare income, retirement, pension, unemployment, and workers compensation).

**Wage earnings =**
5. Denmark: Taxable wage earnings and fringes, labor portion of business income, and non-taxable earnings, severance pay, and stock-options.
6. U.S.: Payroll income from all sources (such as wages and salaries, bonus, overtime income, tips, commissions, professional practice, market gardening, additional job income, and other labor income), farm income, and the labor portion of business income.

**Wage and transfers =**
7. Denmark: Taxable wage earnings and fringes, labor portion of business income, and non-taxable earnings, severance pay, and stock-options, plus taxable and non-taxable public transfers (social assistance, unemployment benefits, labor market leave, sick leave assistance, labor market activation, child benefits, education grants, housing support, early retirement pension, disability pension, and retirement pension).
8. U.S.: Payroll income from all sources, farm income, labor portion of business income, and public transfers.

**Net-of-tax total gross income =**
9. Denmark: Total gross income minus all final income taxes paid in given year. We do not have information on individual net-of-tax income from the PSID.
Table A6: Rank-rank estimates with different income measures, Denmark and the U.S.

<table>
<thead>
<tr>
<th></th>
<th>Gross income excl. public transfers</th>
<th>Gross income incl. public transfers</th>
<th>Wage earnings</th>
<th>Wage earnings and public transfers</th>
<th>Net-of-tax total gross income</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
<tr>
<td>Denmark</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U.S.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Including zeros

<table>
<thead>
<tr>
<th>$\beta_{RR}$</th>
<th>0.273***</th>
<th>0.356***</th>
<th>0.253***</th>
<th>0.205***</th>
<th>0.324***</th>
<th>0.177***</th>
<th>0.316***</th>
<th>0.229***</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.038)</td>
<td>(0.002)</td>
<td>(0.038)</td>
<td>(0.002)</td>
<td>(0.038)</td>
<td>(0.002)</td>
<td>(0.038)</td>
</tr>
</tbody>
</table>

Excluding zeros

<table>
<thead>
<tr>
<th>$\beta_{RR}$</th>
<th>0.274***</th>
<th>0.245***</th>
<th>0.253***</th>
<th>0.205***</th>
<th>0.227***</th>
<th>0.177***</th>
<th>0.224***</th>
<th>0.229***</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.037)</td>
<td>(0.002)</td>
<td>(0.037)</td>
<td>(0.002)</td>
<td>(0.037)</td>
<td>(0.002)</td>
<td>(0.037)</td>
</tr>
</tbody>
</table>

Note: Table shows coefficients from rank-rank estimation ($\beta_{RR}$) and standard errors from regressions of children’s rank in their income distributions on parental rank in their income distributions for Denmark and the U.S. For Denmark, we use full population register data for children born in 1973–1975 and for the U.S., we use PSID data for children born in 1972–1978. For Denmark, parental income is measured as a 9 year average from the child’s 7th to 15th year and the child’s income is measured at ages 35–37, 36–38, and 37–39 for the 1975, 1974, and 1973 cohorts, respectively. For the U.S., parental income is measured as a 9 year average from the child’s 7th to 15th year and the child’s income is measured as last year income at ages 34–41, 33–40, 32–39, 31–38, 30–37, 30–36, and 30–35 for the 1972, 1973, 1974, 1975, 1976, 1977, and 1978 cohorts, respectively.

Total gross income excl. public transfers =
1 Denmark: All taxable income including wage earnings, profits from own business, capital income, and foreign income excluding all public transfers (both taxable and non-taxable).
2 U.S.: All taxable income including earnings (payroll income from all sources, farm income, and the labor portion of business income), asset income (such as rent income, dividends, interest, income from trust and royalties, and asset income from business), and private transfers (such as income from alimony, child support, and help from relatives and others).

Total gross income incl. public transfers =
3 Denmark: All taxable income including wage earnings, public transfers, profits from own business, capital income, and foreign income.
4 U.S.: All taxable income including earnings, asset income, private transfers, and public transfers (such as social security income, SSI, TANF, ETC, other welfare income, retirement, pension, unemployment, and workers compensation).

Wage earnings =
5 Denmark: Taxable wage earnings and fringes, labor portion of business income, and non-taxable earnings, severance pay, and stock-options.
6 U.S.: Payroll income from all sources (such as wages and salaries, bonus, overtime income, tips, commissions, professional practice, market gardening, additional job income, and other labor income), farm income, and the labor portion of business income.

Wage and transfers =
7 Denmark: Taxable wage earnings and fringes, labor portion of business income, and non-taxable earnings, severance pay, and stock-options, plus taxable and non-taxable public transfers (social assistance, unemployment benefits, labor market leave, sick leave assistance, labor market activation, child benefits, education grants, housing support, early retirement pension, disability pension, and retirement pension).
8 U.S.: Payroll income from all sources, farm income, labor portion of business income, and public transfers.

Net-of-tax total gross income =
9 Denmark: Total gross income minus all final income taxes paid in given year. We do not have information on individual net-of-tax income from the PSID.
Table A7: IGE estimates with different income measures, Denmark and the U.S., by gender

<table>
<thead>
<tr>
<th></th>
<th>Gross income excl. public transfers</th>
<th>Gross income incl. public transfers</th>
<th>Wage earnings</th>
<th>Wage earnings and public transfers</th>
<th>Net-of-tax total gross income</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
<tr>
<td>Denmark</td>
<td><strong>β</strong> IGE</td>
<td><strong>β</strong> IGE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>0.379***</td>
<td>0.306***</td>
<td>0.321***</td>
<td>0.457***</td>
<td>0.094***</td>
</tr>
<tr>
<td></td>
<td>(0.006)</td>
<td>(0.078)</td>
<td>(0.005)</td>
<td>(0.082)</td>
<td>(0.005)</td>
</tr>
<tr>
<td>Females</td>
<td>0.328***</td>
<td>0.241***</td>
<td>0.222***</td>
<td>0.381***</td>
<td>0.071***</td>
</tr>
<tr>
<td></td>
<td>(0.006)</td>
<td>(0.005)</td>
<td>(0.004)</td>
<td>(0.101)</td>
<td>(0.004)</td>
</tr>
</tbody>
</table>

Note: Table shows coefficients (**β** IGE) and standard errors from regressions of child’s log income on parental log income on for Denmark and the U.S. by gender of the child. For Denmark, we use full population register data for children born in 1973–1975 and for the U.S., we use PSID data for children born in 1972–1978. For Denmark, parental income is measured as a 9 year average from the child’s 7th to 15th year and the child’s income is measured at ages 35–37, 36–38, and 37–39 for the 1975, 1974, and 1973 cohorts, respectively. For the U.S., parental income is measured as a 9 year average from the child’s 7th to 15th year and the child’s income is measured as last year income at ages 34–41, 33–40, 32–39, 31–38, 30–37, 30–36, and 30–35 for the 1972, 1973, 1974, 1975, 1976, 1977, and 1978 cohorts, respectively. Income variables defined as detailed in Table 1.
Table A8: Covariance matrix: Intergenerational income elasticity, wage income, Denmark

<table>
<thead>
<tr>
<th>Wage income</th>
<th>Child</th>
<th>Parents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wage income, child</td>
<td>1.442</td>
<td></td>
</tr>
<tr>
<td>Wage income, parents</td>
<td>0.140</td>
<td>0.970</td>
</tr>
</tbody>
</table>

$\text{IGE, wage income} = \frac{0.140}{0.970} = 0.145$

Note: Table shows covariance matrix used to construct $\beta^{\text{IGE}} = \frac{\text{cov}(\text{child}, \text{parent})}{\text{var}(\text{parent})}$. Income measures for parents and child are the same in each regression, i.e., parent wage on child’s wage, etc. Parental income is measured as a 9 year average from the child’s 7th to 15th year and the child’s income is measured at ages 35–37, 36–38, and 37–39 for the 1975, 1974, and 1973 cohorts, respectively. 
Wage income = taxable wage earnings (including self-employment income) and fringes, and non-taxable earnings, severance pay, and stock-options.
Number of observations: 163,123.
Table A9: Covariance matrix: Intergenerational income elasticity, wage income and profits from own business, Denmark

<table>
<thead>
<tr>
<th>Aggregated measure</th>
<th>Wage income and profits</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Child</td>
<td>Parents</td>
</tr>
<tr>
<td>Wage income and profits, child</td>
<td>1.169</td>
<td></td>
</tr>
<tr>
<td>Wage income and profits, parents</td>
<td>0.131</td>
<td>0.290</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Individual components</th>
<th>Wage income</th>
<th>Profits from business</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Child</td>
<td>Parents</td>
</tr>
<tr>
<td>Wage income, child</td>
<td>1.442</td>
<td></td>
</tr>
<tr>
<td>Wage income, parents</td>
<td>0.140</td>
<td>0.970</td>
</tr>
<tr>
<td>Profits, child</td>
<td>-0.336</td>
<td>-0.046</td>
</tr>
<tr>
<td>Profits, parents</td>
<td>-0.012</td>
<td>-0.649</td>
</tr>
</tbody>
</table>

\[
\text{IGE, wage income and profits from business} = \frac{0.049 + 0.140 - 0.012 - 0.046}{0.970 + 0.617 + 2(-0.649)} = \frac{0.131}{0.290} = 0.451.
\]

Note: Table shows covariance matrix used to construct \( \beta^{\text{IGE}} = \frac{\text{cov}(\text{child}, \text{parent})}{\text{var}(\text{parent})} \).
- Profits from own business is calculated as \( \ln(\text{wage income} + \text{profits from business}) - \ln(\text{wage income}) \) such that IGE can be calculated as the sum of intergenerational covariances divided by parental variances/covariances as reported in the table.
- Income measures for parents and child are the same in each regression, i.e., parent wage on child’s wage, etc. Parental income is measured as a 9 year average from the child’s 7th to 15th year and the child’s income is measured at ages 35–37, 36–38, and 37–39 for the 1975, 1974, and 1973 cohorts, respectively.

Wage income = taxable wage earnings (including self-employment income) and fringes, and non-taxable earnings, severance pay, and stock-options.

Profits from own business = Profits from independent business or firm including foreign business income and net revenue from employed spouse. Excluding capital revenue and expenses.

Number of observations: 163,123.
Table A10: Covariance matrix: Intergenerational income elasticity, total gross income excluding public transfers, Denmark

<table>
<thead>
<tr>
<th>Aggregated measure</th>
<th>Total gross income excl. transfers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Child</td>
</tr>
<tr>
<td>Total gross income excl. transfers, child</td>
<td>1.130</td>
</tr>
<tr>
<td>Total gross income excl. transfers, parents</td>
<td>0.140</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Individual components</th>
<th>Wage income</th>
<th>Profits from business</th>
<th>Capital income</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Child</td>
<td>Parents</td>
<td>Child</td>
</tr>
<tr>
<td>Wage income, child</td>
<td>1.442</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wage income, parents</td>
<td>0.140</td>
<td>0.970</td>
<td></td>
</tr>
<tr>
<td>Profits, child</td>
<td>-0.336</td>
<td>-0.046</td>
<td>0.399</td>
</tr>
<tr>
<td>Profits, parents</td>
<td>-0.012</td>
<td>-0.649</td>
<td>0.049</td>
</tr>
<tr>
<td>Capital income, child</td>
<td>-0.018</td>
<td>0.001</td>
<td>-0.012</td>
</tr>
<tr>
<td>Capital income, parents</td>
<td>-0.0003</td>
<td>-0.104</td>
<td>0.009</td>
</tr>
</tbody>
</table>

IGE, total gross income excluding public transfers = \[
\frac{0.131 + 0.0002 - 0.001 + 0.001 + 0.009 - 0.0003}{0.290 + 0.032 + 2\times(-0.104) + 2\times(0.086)}
\]
\[
= \frac{0.140}{0.285} = 0.490
\]

Note: Table shows covariance matrix used to construct \( \beta_{IGE} = \frac{cov(\text{child}, \text{parent})}{var(\text{parent})} \).
- Profits from own business is calculated as \(\ln(\text{wage income} + \text{profits from business}) - \ln(\text{wage income})\).
- Capital income is here defined as the residual to total gross income excluding transfers, and is calculated as \(\ln(\text{total gross income excl. transfers}) - \ln(\text{wage income} + \text{profits from business})\) such that IGE can be calculated as the sum of intergenerational covariances divided by parental variances/covariances as reported in the table.
Income measures for parents and child are the same in each regression, i.e., parent wage on child’s wage, etc. Parental income is measured as a 9 year average from the child’s 7th to 15th year and the child’s income is measured at ages 35–37, 36–38, and 37–39 for the 1975, 1974, and 1973 cohorts, respectively.

Wage income = taxable wage earnings (including self-employment income) and fringes, and non-taxable earnings, severance pay, and stock-options.

Profits from own business = Profits from independent business or firm including foreign business income and net revenue from employed spouse. Excluding capital revenue and expenses.

Capital income = Capital income including stock income and foreign income.

Number of observations: 163,123.
Table A11: Covariance matrix: Intergenerational income elasticity, total gross income including public transfers, Denmark

<table>
<thead>
<tr>
<th>Aggregated measure</th>
<th>Total gross income incl. transfers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Child</td>
</tr>
<tr>
<td>Total gross income incl. transfers, child</td>
<td>0.240</td>
</tr>
<tr>
<td>Total gross income incl. transfers, parents</td>
<td>0.034</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Individual components</th>
<th>Wage income</th>
<th>Profits from business</th>
<th>Capital income</th>
<th>Transfers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Child</td>
<td>Parents</td>
<td>Child</td>
<td>Parents</td>
</tr>
<tr>
<td>Wage income, child</td>
<td>1.442</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wage income, parents</td>
<td>0.140</td>
<td>0.970</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profits, child</td>
<td>-0.336</td>
<td>-0.046</td>
<td>0.399</td>
<td></td>
</tr>
<tr>
<td>Profits, parents</td>
<td>-0.012</td>
<td>-0.649</td>
<td>0.049</td>
<td>0.617</td>
</tr>
<tr>
<td>Capital income, child</td>
<td>-0.018</td>
<td>0.001</td>
<td>-0.012</td>
<td>-0.001</td>
</tr>
<tr>
<td>Capital income, parents</td>
<td>-0.0003</td>
<td>-0.104</td>
<td>0.009</td>
<td>0.086</td>
</tr>
<tr>
<td>Transfers, child</td>
<td>-0.699</td>
<td>-0.054</td>
<td>-0.034</td>
<td>-0.024</td>
</tr>
<tr>
<td>Transfers, parents</td>
<td>-0.065</td>
<td>-0.104</td>
<td>-0.004</td>
<td>-0.019</td>
</tr>
</tbody>
</table>

\[
IGE, \text{ total gross income including public transfers} = \frac{0.140 + 0.045 + 0.0003 - 0.004 - 0.005 - 0.024 - 0.054}{0.286 + 0.083 - 2 \times (0.003) - 2 \times (0.019) - 2 \times (0.104)} \times \frac{0.034}{0.116} = 0.290
\]

Note: Table shows covariance matrix used to construct \( \beta^{IGE} = \frac{cov\text{(child, parent)}}{var\text{(parent)}} \).
- Profits from own business is calculated as ln(wage income + profits from business) – ln(wage income).
- Capital income is here defined as the residual to total gross income excluding transfers, and is calculated as ln(total gross income excl. transfers) – ln(wage income + profits from business).
- Transfers is calculated as ln(total gross income incl. transfers) – ln(total gross income excl. transfers) such that IGE can be calculated as the sum of intergenerational covariances divided by parental variances/covariances as reported in the table. Income measures for parents and child are the same in each regression, i.e., parent wage on child’s wage, etc. Parental income is measured as a 9 year average from the child’s 7th to 15th year and the child’s income is measured at ages 35–37, 36–38, and 37–39 for the 1975, 1974, and 1973 cohorts, respectively.
- Wage income = taxable wage earnings (including self-employment income) and fringes, and non-taxable earnings, severance pay, and stock-options.
- Profits from own business = Profits from independent business or firm including foreign business income and net revenue from employed spouse. Excluding capital revenue and expenses.
- Capital income = Capital income including stock income and foreign income.
- Transfers = Taxable and non-taxable public transfers (social assistance, unemployment benefits, labor market leave, sick leave assistance, labor market activation, child benefits, education grants, housing support, early retirement pension, disability pension, and retirement pension).

Number of observations: 163,123.
## Table A12: Covariance matrix: Intergenerational income elasticity, total net-of-tax (disposable) income, Denmark

<table>
<thead>
<tr>
<th>Aggregated measure</th>
<th>Total net-of-tax income</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Child</td>
</tr>
<tr>
<td>Total net-of-tax income, child</td>
<td>0.199</td>
</tr>
<tr>
<td>Total net-of-tax income, parents</td>
<td>0.025</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Individual components</th>
<th>Wage income</th>
<th>Profits from business</th>
<th>Capital income</th>
<th>Transfers</th>
<th>Taxes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Child</td>
<td>Parents</td>
<td>Child</td>
<td>Parents</td>
<td></td>
</tr>
<tr>
<td>Wage income, child</td>
<td>1.442</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wage income, parents</td>
<td>0.140</td>
<td>0.970</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profits, child</td>
<td>-0.336</td>
<td>-0.046</td>
<td>0.399</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profits, parents</td>
<td>-0.012</td>
<td>-0.649</td>
<td>0.049</td>
<td>0.617</td>
<td></td>
</tr>
<tr>
<td>Capital income, child</td>
<td>-0.018</td>
<td>0.001</td>
<td>-0.012</td>
<td>-0.001</td>
<td>0.022</td>
</tr>
<tr>
<td>Capital income, parents</td>
<td>-0.0003</td>
<td>-0.104</td>
<td>0.009</td>
<td>0.086</td>
<td>0.002</td>
</tr>
<tr>
<td>Transfers, child</td>
<td>-0.699</td>
<td>-0.054</td>
<td>-0.034</td>
<td>-0.024</td>
<td>0.006</td>
</tr>
<tr>
<td>Transfers, parents</td>
<td>-0.065</td>
<td>-0.104</td>
<td>-0.004</td>
<td>-0.019</td>
<td>0.0003</td>
</tr>
<tr>
<td>Taxes, child</td>
<td>-0.043</td>
<td>-0.008</td>
<td>0.003</td>
<td>0.001</td>
<td>-0.0004</td>
</tr>
<tr>
<td>Taxes, parents</td>
<td>-0.015</td>
<td>-0.059</td>
<td>0.004</td>
<td>0.028</td>
<td>-0.0002</td>
</tr>
</tbody>
</table>

\[
\text{IGE, total net-of-tax income including public transfers} = \frac{0.034 \cdot -0.015 \cdot 0.006 - 0.0002 \cdot 0.004 \cdot 0.002 - 0.0004 \cdot 0.001 - 0.009}{0.116 + 0.015 + 0.006 + 2 \cdot 0.006 + 2 \cdot 0.004 + 2 \cdot \left( -0.009 \right)} = 0.245
\]

Note: Table shows covariance matrix used to construct \( \beta_{\text{IGE}} = \frac{\text{cov}(\text{child}, \text{parent})}{\text{var}(\text{parent})} \).

- Profits from business is calculated as \( \ln(\text{wage income} + \text{profits from business}) - \ln(\text{wage income}) \).
- Capital income is here defined as the residual to total gross income excluding transfers, and is calculated as \( \ln(\text{total gross income excl. transfers}) - \ln(\text{wage income} + \text{profits from business}) \).
- Transfers is calculated as \( \ln(\text{total gross income incl. transfers}) - \ln(\text{total gross income excl. transfers}) \).
- Taxes is calculated as \( \ln(\text{total net-of-tax income}) - \ln(\text{total gross income incl. transfers}) \) such that IGE can be calculated as the sum of intergenerational covariances divided by parental variances/covariances as reported in the table.

Income measures for parents and child are the same in each regression, i.e., parent wage on child’s wage, etc. Parental income is measured as a 9 year average from the child’s 7th to 15th year and the child’s income is measured at ages 35–37, 36–38, and 37–39 for the 1975, 1974, and 1973 cohorts, respectively.

- \text{Wage income} = \text{taxable wage earnings (including self-employment income) and fringes, and non-taxable earnings, severance pay, and stock-options.}
- \text{Profits from own business} = \text{Profits from independent business or firm including foreign business income and net revenue from employed spouse. Excluding capital revenue and expenses.}
- \text{Capital income} = \text{Capital income including stock income and foreign income.}
- \text{Transfers} = \text{Taxable and non-taxable public transfers (social assistance, unemployment benefits, labor market leave, sick leave assistance, labor market activation, child benefits, education grants, housing support, early retirement pension, disability pension, and retirement pension).}
- \text{Taxes} = \text{Total taxes paid as wage income tax, including business, property, and capital income taxes.}

Number of observations: 163,123.
Figure A2: Wage earnings transformation, from Denmark to the U.S. and vice versa

(a) Wage earnings transformation, Danish to U.S. distribution

(b) Wage earnings transformation, U.S. to Danish distribution

Note: Figures show wage earnings distributions for the U.S. and Denmark. The arrows provide an illustration of how distributions from the U.S. are mapped to Danish distributions and vice versa. Mapping is performed for each percentile and not just the three arrows shown in each figure.
Figure A3: Child-parent income plots, Denmark

(a) Total gross income excl. transfers

(b) Total gross income incl. transfers

(c) Wage income

(d) Wage income plus transfers

(e) Total net-of-tax income incl. transfers

Note: Figure shows scatterplots of parental log income on child’s log income for children born in 1973–1975. Parental income is measured as a 9 year average from the child’s 7th to 15th year and the child’s income is measured at ages 35–37, 36–38, and 37–39 for the 1975, 1974, and 1973 cohorts, respectively.
Figure A4: Child-parent income plots, Denmark

(a) Total gross income excl. transfers  (b) Total gross income incl. transfers

(c) Wage income  (d) Wage income plus transfers

Note: Figure shows scatterplots of parental log income on child’s log income for children born in 1973–1975. Parental income is measured as a 9 year average from the child’s 7th to 15th year and the child’s income is measured at ages 35–37, 36–38, and 37–39 for the 1975, 1974, and 1973 cohorts, respectively.
Figure A5: Local Intergenerational Income-Elasticity in Denmark and the U.S., estimated using absolute income

Denmark
(a) Total gross income excl. public transfers  (b) Total gross income incl. public transfers

U.S.
(c) Total gross income excl. public transfers  (d) Total gross income incl. public transfers

Note: Figures show estimated Intergenerational Income-Elasticities of wage income plus public transfers for Denmark (a, b) and the U.S. (c, d). Figures a and b have been constructed using full population register data from Denmark, and Figures c and d have been constructed using PSID data. The figures show local linear regression slopes of children’s income on parental income. Estimates have then been converted to change in percentages relative to the base for each point of parental income $Y_P^0$. LLRs are weighted using kernels of absolute income. Standard errors for Figures a and b have been constructed from 50 bootstraps and standard errors for Figures c and d have been constructed from 1,000 bootstraps. The vertical lines indicate the 5th and 95th percentiles in the respective income distributions (except for Total gross income excl. public transfers and Total gross income excl. public transfers in Denmark, because the 99th income percentiles in the full population register data are above $150,000).
Figure A6: Local Intergenerational Income-Elasticity in Denmark and the U.S., estimated using absolute income, cont.

Denmark

(a) Wage earnings
(b) Wage earnings and transfers
(c) Net-of-tax total gross income

U.S.

(d) Wage earnings
(e) Wage earnings and transfers

**Note:** Figures show estimated Intergenerational Income-Elasticities of wage income plus public transfers for Denmark (a, b, c) and the U.S. (d, e). Figures a, b, and c have been constructed using full population register data from Denmark, and Figures d and e have been constructed using PSID data. The figures show local linear regression slopes of children’s income on parental income. Estimates have then been converted to change in percentages relative to the base for each point of parental income $Y_P^0$. LLRs are weighted using kernels of absolute income. Standard errors for Figures a, b, and c have been constructed from 50 bootstraps and standard errors for Figures d and e have been constructed from 1,000 bootstraps.

The vertical lines indicate the 5th and 95th percentiles in the respective income distributions (except for Total gross income excl. public transfers and Total gross income excl. public transfers in Denmark, because the 99th income percentiles in the full population register data are above $150,000).
### A.2 Supplements to Section 3

Table A13: Expenditure on educational institutions as a percentage of GDP, by source of funding and level of education

<table>
<thead>
<tr>
<th></th>
<th>Prim., secon., and post-secon.</th>
<th>Pre-primary</th>
<th>non-tertiary</th>
<th>Tertiary</th>
<th>All levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Public(^1)</td>
<td>Private(^2)</td>
<td>Total</td>
<td>Public(^1)</td>
<td>Private(^2)</td>
</tr>
<tr>
<td>Denmark</td>
<td>1.30</td>
<td>0.11</td>
<td><strong>1.41</strong></td>
<td>4.3</td>
<td>0.1</td>
</tr>
<tr>
<td>Norway</td>
<td>0.48</td>
<td>0.03</td>
<td><strong>0.51</strong></td>
<td>4.9</td>
<td>na</td>
</tr>
<tr>
<td>Sweden</td>
<td>0.72</td>
<td>0.00</td>
<td><strong>0.72</strong></td>
<td>3.9</td>
<td>0.0</td>
</tr>
<tr>
<td>United States</td>
<td>0.33</td>
<td>0.14</td>
<td><strong>0.47</strong></td>
<td>3.4</td>
<td>0.3</td>
</tr>
</tbody>
</table>

**Note:** Table shows public, private, and total expenditures on education as percentages of GDP in 2013 for Denmark, Norway, Sweden, and the U.S.

\(^1\): Including public subsidies to households attributable for educational institutions, tuition and fees (U.S.), and direct expenditure on educational institutions.

\(^2\): Net of public subsidies attributable for educational institutions.

**Source:** Organisation for Economic Co-operation and Development (2014).
Table A14: Educational levels and source of finance, Denmark and the U.S.

<table>
<thead>
<tr>
<th>Age</th>
<th>Level/Grade</th>
<th>Public funding</th>
<th>Level/Grade</th>
<th>Public funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>52 weeks leave shared between parents</td>
<td>$200–600 per week publicly funded</td>
<td>Preschool</td>
<td>Most states: free below poverty line$†$</td>
</tr>
<tr>
<td>1</td>
<td>Daycare or family care</td>
<td>$14,000 funded (75%) from municipality*</td>
<td>Preschool</td>
<td>Most states: free below poverty line$†$</td>
</tr>
<tr>
<td>2</td>
<td>Daycare or family care</td>
<td>$14,000 funded (75%) from municipality*</td>
<td>Preschool</td>
<td>Most states: free below poverty line$†$</td>
</tr>
<tr>
<td>3</td>
<td>Preschool, daycare, or family care</td>
<td>$10–14,000 funded (75%) from municipality*</td>
<td>Preschool</td>
<td>Most states: free below poverty line$†$</td>
</tr>
<tr>
<td>4</td>
<td>Preschool</td>
<td>$10,000 funded (75%) from municipality*</td>
<td>Preschool</td>
<td>Most states: free below poverty line$†$</td>
</tr>
<tr>
<td>5</td>
<td>Preschool</td>
<td>$10,000 funded (75%) from municipality*</td>
<td>Preschool</td>
<td>Most states: free below poverty line$†$</td>
</tr>
<tr>
<td>6</td>
<td>Kindergarten</td>
<td>Funded by municipality</td>
<td>Kindergarten</td>
<td>Funded by school district, state, and federal</td>
</tr>
<tr>
<td>7</td>
<td>1st grade</td>
<td>-</td>
<td>1st grade</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>2nd grade</td>
<td>-</td>
<td>2nd grade</td>
<td>-</td>
</tr>
<tr>
<td>9</td>
<td>3rd grade</td>
<td>-</td>
<td>3rd grade</td>
<td>-</td>
</tr>
<tr>
<td>10</td>
<td>3rd grade</td>
<td>-</td>
<td>4th grade</td>
<td>-</td>
</tr>
<tr>
<td>11</td>
<td>6th grade</td>
<td>-</td>
<td>5th grade</td>
<td>-</td>
</tr>
<tr>
<td>12</td>
<td>5th grade</td>
<td>-</td>
<td>6th grade</td>
<td>-</td>
</tr>
<tr>
<td>13</td>
<td>7th grade</td>
<td>-</td>
<td>7th grade</td>
<td>-</td>
</tr>
<tr>
<td>14</td>
<td>8th grade</td>
<td>-</td>
<td>8th grade</td>
<td>-</td>
</tr>
<tr>
<td>15</td>
<td>9th grade</td>
<td>-</td>
<td>9th grade, high school</td>
<td>-</td>
</tr>
<tr>
<td>16</td>
<td>1st year gymnasium or vocational</td>
<td>Funded by municipality/state</td>
<td>10th grade, high school</td>
<td>Funded by school district, state, and federal</td>
</tr>
<tr>
<td>17</td>
<td>2nd year gymnasium or vocational</td>
<td>Funded by municipality/state + educational support</td>
<td>11th grade, high school</td>
<td>Funded by school district, state, and federal</td>
</tr>
<tr>
<td>18</td>
<td>3rd year gymnasium or vocational</td>
<td>-</td>
<td>12th grade, high school</td>
<td>Funded by school district, state, and federal</td>
</tr>
<tr>
<td>19</td>
<td>1st year university/college</td>
<td>Funded by state + educational support</td>
<td>College, undergraduate, freshman</td>
<td>Funded by state, federal, and private donations/tuition</td>
</tr>
<tr>
<td>20</td>
<td>2nd year university/college</td>
<td>-</td>
<td>College, undergraduate, sophomore</td>
<td>Funded by state, federal, and private donations/tuition</td>
</tr>
<tr>
<td>21</td>
<td>3rd year university/college</td>
<td>-</td>
<td>College, undergraduate, junior</td>
<td>Funded by state, federal, and private donations/tuition</td>
</tr>
<tr>
<td>22</td>
<td>4th year university/college</td>
<td>-</td>
<td>College, undergraduate, senior</td>
<td>Funded by state, federal, and private donations/tuition</td>
</tr>
<tr>
<td>23</td>
<td>5th year university</td>
<td>-</td>
<td>Varying graduate</td>
<td>Funded by state, federal, and private donations/tuition</td>
</tr>
<tr>
<td>24</td>
<td>1st year PhD</td>
<td>Public scholarships for tuition/income</td>
<td>Varying graduate</td>
<td>Funded by state, federal, and private donations/tuition</td>
</tr>
<tr>
<td>25</td>
<td>2nd year PhD</td>
<td>Public scholarships for tuition/income</td>
<td>Varying graduate</td>
<td>Funded by state, federal, and private donations/tuition</td>
</tr>
<tr>
<td>26</td>
<td>3rd year PhD</td>
<td>Public scholarships for tuition/income</td>
<td>Varying graduate</td>
<td>Funded by state, federal, and private donations/tuition</td>
</tr>
</tbody>
</table>

* Highest rate of parental payment: Means tested for low incomes where subsidies increase to 100%.

Note: Table provides a broad overview of the educational ladder in Denmark and the U.S. together with levels of public funding at each educational level.

Figure A7: Percentage of adults ages 16 to 65 at each level of proficiency, 2012

(a) PIAAC numeracy scale

(b) PIAAC literacy scale


Figure A8: Percent of population aged 16–65, IALS 1994–1998

(a) Quantitative literacy level

(b) Document literacy level

(c) Prose literacy level

Figure A9: Proportion of the population that has attained at least upper secondary education, by age group (2012), Denmark, Norway, and the U.S.

Note: Figure shows proportion of the population that has attained at least upper secondary education, by age group in 2012, for Denmark, Norway, and the U.S.

Figure A10: Levels of educational attainment in 2000 and 2012, Denmark, Norway, and the U.S.

(a) Denmark

(b) Norway

(c) U.S.

Note: Figure shows fraction of 25–34 year olds with below upper secondary, upper secondary or post-secondary (non-tertiary), and tertiary education in 2000 and 2012, for Denmark, Norway, and the U.S. Source: Organisation for Economic Co-operation and Development (2014, Table A1.4a).
Figure A11: Parents’ educational attainment in the total population of 20–34 year olds, Denmark, Norway, and the U.S.

Note: Figure shows fraction of parents with different levels of educational attainment (below upper secondary, upper secondary or post-secondary (non-tertiary), and tertiary education) in 2012, for full populations (students and non-students) in Denmark, Norway, and the U.S.

Figure A12: Total enrollment in tertiary education of 20–34 year olds by parents’ educational attainment (below upper secondary, upper secondary or post-secondary (non-tertiary), and tertiary education) in 2012, for Denmark, Norway, and the U.S.

Note: Figure shows proportion of 20–34 year olds in tertiary education, by parents’ educational attainment (below upper secondary, upper secondary or post-secondary (non-tertiary), and tertiary education), as fraction of all 20–34 year olds, in 2012, for Denmark, Norway, and the U.S. 
Source: Own calculations based on Organisation for Economic Co-operation and Development (2014, Chart A4.1).
Figure A13: Intergenerational education coefficients from average parent-child schooling, ages 20–64

Note: Figure shows coefficients from children’s years of schooling on average parents’ years of schooling measured in the population aged 20–64, for different countries. Surveyed between 1994 and 2004, except Peru (1985), Malaysia (1988) and Pakistan (1991). * Ages 20 to 64 or 65 only.

Source: Hertz et al. (2008).
Figure A14: High school completion and college attendance by parental income and wealth level (where there is overlap in support)

(a) High school completion, U.S.   (b) High school completion, Denmark

(c) College attendance, U.S.   (d) College attendance, Denmark

Note: Figures show children’s high school completion and college attendance rates by parental levels of income and net wealth for the ranges of income and wealth where we have overlap in support between the two countries. The figures are constructed using data from the CNLSY for the U.S. and administrative register data on the full cohort born in 1987 for Denmark. In the CNLSY data, we measure income using the sum of the mother’s and her spouse’s self-reported wage earnings and for Denmark, we measure income as the sum of the mother’s and father’s wage earnings. For both countries, we measure income as average income between the child’s 3rd and 15th year. For the U.S., we measure assets as reported net assets in the CNLSY. For Denmark, assets are measured as net assets (excluding pension savings) from income and wealth data reported to tax authorities. In both countries, we measure assets at age 15 of the child. The corresponding results by parental income and wealth quantiles are shown in Figure A16 and the figures for the full ranges of support in each country are shown in Figure A14. Colors indicate levels of the outcome variable on the z-axis (high school completion and college attendance). Lighter indicates a lower levels and darker indicates higher level of the outcome.
Figure A15: High school completion and college attendance by parental income and wealth level (all observed levels of income and wealth)

(a) High school completion, U.S.  
(b) High school completion, Denmark  
(c) College attendance, U.S.  
(d) College attendance, Denmark

Note: Figures constructed using data from the CNLSY for the U.S. and administrative register data on the full cohort born in 1987 for Denmark. In the CNLSY data, we measure income using the sum of the mother’s and her spouse’s self-reported wage earnings and for Denmark, we measure income as the sum of the mother’s and father’s wage earnings. For both countries, we measure income as average income between the child’s 3rd and 15th year. For the U.S., we measure assets as reported net assets in the CNLSY. For Denmark, assets are measured as net assets (excluding pension savings) from income and wealth data reported to tax authorities. In both countries, we measure assets at age 15 of the child. The corresponding results by parental income and wealth quantiles are shown in Figure A16. Colors indicate levels of the outcome variable on the z-axis (high school completion and college attendance). Lighter indicates a lower levels and darker indicates higher level of the outcome.
Figure A16: High school completion and college attendance by parental income and wealth rank

(a) High school completion, U.S.

(b) High school completion, Denmark

(c) College attendance, U.S.

(d) College attendance, Denmark

Note: Figures constructed using data from the CNLSY for the U.S. and administrative register data for Denmark. In the CNLSY data, we measure income using the sum of the mother’s and her spouse’s self-reported wage earnings and for Denmark, we measure income as the sum of the mother’s and father’s wage earnings. For both countries, we measure income as average income between the child’s 3rd and 15th year. For the U.S., we measure assets as reported net assets in the CNLSY. For Denmark, assets are measured as net assets (excluding pension savings) from income and wealth data reported to tax authorities. In both countries, we measure assets at age 15 of the child. The figures correspond to Figure A14. Colors indicate levels of the outcome variable on the z-axis (high school completion and college attendance). Lighter indicates a lower levels and darker indicates higher level of the outcome.
Figure A17: Schooling and log of parental wage income and wage income including UI and welfare, U.S. vs. Denmark

(a) High school completion and college attendance, U.S.

(b) High school completion, Denmark

(c) College attendance, Denmark

Note: Figures show high school completion and college attendance rates by parental income levels (permanent wage or permanent wage plus public transfers), using the CNLSY and the full cohort born in 1987 in Denmark. In the CNLSY data, we measure wage income using the sum of the mother’s and her spouse’s self-reported wage earnings and for Denmark, we measure wage income as the sum of the mother’s and father’s wage earnings. In both countries, wage income + UI/welfare is measured as wage income and all information on reception of public benefits (survey information from CNLSY in the U.S. and register data from tax records in Denmark). For both countries, we measure income as average income between the child’s 3rd and 15th year. Bins calculated as means of every second income percentile for each income measure, respectively. Results for wage income + UI and welfare benefits in the U.S. not shown.
Figure A18: Schooling and parental income rank by parental wage income or wage income including UI and welfare, U.S. vs. Denmark

(a) High school completion, U.S.  
(b) College attendance, U.S.  
(c) High school completion, Denmark  
(d) College attendance, Denmark

Note: Figures show high school completion and college attendance rates for Denmark and the U.S. constructed from CNLSY data and the cohort born in 1987 in Denmark. The dashed lines indicate 95% confidence intervals. Scatterplots in Figures c and d shows parental mean wealth rank by bins of percentiles of wage income plus public benefits.
Figure A19: U.S./Denmark differences in high school completion and college attendance by parental income and wealth level

(a) High school completion

(b) College attendance

Note: Figures constructed using data from the CNLSY for the U.S. and administrative register data on the full cohort born in 1987 for Denmark. Figures show U.S. level of college attendance minus the Danish level by log levels of parental permanent income and wealth.

In the CNLSY data, we measure income using the sum of the mother’s and her spouse’s self-reported wage earnings and for Denmark, we measure income as the sum of the mother’s and father’s wage earnings. For both countries, we measure income as average income between the child’s 3rd and 15th year. For the U.S., we measure assets as reported net assets in the CNLSY. For Denmark, assets are measured as net assets (excluding pension savings) from income and wealth data reported to tax authorities. In both countries, we measure assets at age 15 of the child.

The corresponding results for parental income and wealth quantiles are shown in Figure A20. Red indicates that the U.S. level is higher than the Danish level for a given combination of parental income/wealth. Blue indicates that the Danish level is higher than the U.S. level for a given combination of parental income/wealth.
Figure A20: U.S./Denmark differences in high school completion and college attendance by parental income and wealth rank

(a) High school completion

(b) College attendance

Note: Figures constructed using data from the CNLSY for the U.S. and administrative register data for Denmark. In the CNLSY data, we measure income using the sum of the mother’s and her spouse’s self-reported wage earnings and for Denmark, we measure income as the sum of the mother’s and father’s wage earnings. For both countries, we measure income as average income between the child’s 3rd and 15th year. For the U.S., we measure assets as reported net assets in the CNLSY. For Denmark, assets are measured as net assets (excluding pension savings) from income and wealth data reported to tax authorities. In both countries, we measure assets at age 15 of the child. The figures correspond to Figure A19. Red indicates that the U.S. level is higher than the Danish level for a given combination of parental income/wealth. Blue indicates that the Danish level is higher than the U.S. level for a given combination of parental income/wealth.
Table A15: Regression coefficients for high school completion and college attendance on parental resources, with equal year of birth distributions and sample sizes

<table>
<thead>
<tr>
<th></th>
<th>(1) U.S., CNLSY</th>
<th>(2) Denmark, cohort 1987</th>
<th>(3) Denmark, cohort distribution as in CNLSY</th>
<th>(4) Denmark, cohort distribution and sample size as in CNLSY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parental permanent wage income ages 3-15</td>
<td>0.033***</td>
<td>0.066***</td>
<td>0.061***</td>
<td>0.058***</td>
</tr>
<tr>
<td></td>
<td>(0.009)</td>
<td>(0.003)</td>
<td>(0.002)</td>
<td>(0.008)</td>
</tr>
<tr>
<td>Parental wealth (net assets) age 15</td>
<td>0.020***</td>
<td>0.037***</td>
<td>0.043***</td>
<td>0.043***</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.004)</td>
</tr>
</tbody>
</table>

**College attendance**

| Parental permanent wage income ages 3-15 | 0.063*** | 0.061*** | 0.058*** | 0.058*** |
|                                          | (0.010) | (0.003) | (0.002) | (0.008) |
| Parental wealth (net assets) age 15      | 0.022*** | 0.034*** | 0.033*** | 0.030*** |
|                                          | (0.003) | (0.001) | (0.001) | (0.004) |

| Observations | 3,268 | 39,539 | 50,006 | 3,268 |

Note: Table shows regression coefficients of children’s high school completion and college attendance on parental permanent wage income and wealth for the U.S. and Denmark as shown in Table 4 (columns 1 and 2), and using Danish data with similar cohort distribution as in the CNLSY sample in column 3 and Danish register data with similar cohort distribution and sample size as in the CNLSY sample in Column 4.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. 

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Table A16: Regression coefficients for high school completion and college attendance on ranks of parental resources using different conditioning sets

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>U.S., High school completion</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parental permanent wage income ages 3–15</td>
<td>0.1650***</td>
<td>0.1280***</td>
<td>0.1005***</td>
<td>0.1434***</td>
<td>0.0687+</td>
<td>0.0803*</td>
</tr>
<tr>
<td></td>
<td>(0.0351)</td>
<td>(0.0369)</td>
<td>(0.0364)</td>
<td>(0.0348)</td>
<td>(0.0366)</td>
<td>(0.0366)</td>
</tr>
<tr>
<td>Parental wealth (net assets) age 15</td>
<td>0.2006***</td>
<td>0.1678</td>
<td>0.1438***</td>
<td>0.1340***</td>
<td>0.1368***</td>
<td>0.0980**</td>
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<tr>
<td></td>
<td>(0.0349)</td>
<td>(0.0381)</td>
<td>(0.0352)</td>
<td>(0.0343)</td>
<td>(0.0352)</td>
<td>(0.0366)</td>
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<tr>
<td><strong>Denmark, High school completion</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parental permanent wage income ages 3–15</td>
<td>0.2743***</td>
<td>0.2126***</td>
<td>0.1978***</td>
<td>0.2518***</td>
<td>0.1693**</td>
<td>0.0377***</td>
</tr>
<tr>
<td></td>
<td>(0.0076)</td>
<td>(0.0092)</td>
<td>(0.0082)</td>
<td>(0.0077)</td>
<td>(0.0090)</td>
<td>(0.0049)</td>
</tr>
<tr>
<td>Parental wealth (net assets) age 15</td>
<td>0.2363***</td>
<td>0.1661**</td>
<td>0.1849***</td>
<td>0.2261***</td>
<td>0.1507**</td>
<td>0.0980**</td>
</tr>
<tr>
<td></td>
<td>(0.0076)</td>
<td>(0.0080)</td>
<td>(0.0089)</td>
<td>(0.0076)</td>
<td>(0.0085)</td>
<td>(0.0074)</td>
</tr>
<tr>
<td>∆ Parental permanent wage income ages 3–15</td>
<td>-0.1093</td>
<td>-0.0846</td>
<td>-0.0973</td>
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<td>School characteristics</td>
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Note: Table shows regression coefficients of children’s high school completion and college attendance on ranks of parental permanent wage income and wealth (0-1) while gradually increasing conditioning set with skills, family background, and school characteristics. Table is constructed using data from the CNLSY for the U.S. and administrative register data on the full cohort born in 1987 for Denmark. The table also show p-values from tests of equal slope coefficients against a two-sided alternative.
Family background variables: child gender (0/1), immigrant/minority (0/1), urban region (0/1), siblings, mother’s age at birth, and mother’s years of schooling.
School characteristics for the U.S. include: grade for how teachers care about students, grade for whether school is considered safe, a dummy for whether child feels peer pressure to work hard, a dummy for whether child feels peer pressure to skip school, a dummy for whether child has received sex education in school, and a dummy for whether child attends private school. School characteristics for Denmark include: for each school, the means of previous cohort’s mother’s age at birth, mother’s high school completion, and mother’s college attendance, high school completion, and college attendance.
Observations: U.S. 3,268; Denmark 39,539.

+: p < 0.1, *: p < 0.05, **: p < 0.01, ***: p < 0.001.
Figure A21: Local Intergenerational Elasticities between children’s education and parental log wage earnings, absolute income weights

(a) High school completion, Denmark  
(b) High school completion, U.S.  
(c) High school completion, U.S.-Denmark difference

(d) College completion, Denmark  
(e) College completion, U.S.  
(f) College completion, U.S.-Denmark difference

Note: Figures 7a, b, d, and e show local linear regression slopes of children’s education (high school completion, college graduation) on log of parental wage earnings for Denmark and the U.S. Figures 7c and f show U.S.-Denmark difference in local Intergenerational Elasticities between children’s education and parental log gross income including transfers. High school completion is defined as highest completed grade $\geq 12$, college graduation as highest completed grade $\geq 15$. LLRs are weighted using kernels of absolute income. Standard errors constructed from 50 and 1,000 bootstraps, respectively. The vertical lines mark the 5th and 95th percentiles in the data.
Figure A22: Local Intergenerational regressions between children’s high school completion / college graduation and average of parents’ highest completed grade

(a) High school completion, Denmark

(b) High school completion, U.S.

(c) High school completion, U.S.-Denmark difference

(d) College completion, Denmark

(e) College completion, U.S.

(f) College completion, U.S.-Denmark difference

Note: Figures A22a, b, d, and e show local linear regression slopes of children’s education (high school completion, college graduation) on average of parents’ highest grade completed for Denmark and the U.S. Figures A22c and f show U.S.-Denmark difference in local linear regression slopes between children’s education and average of highest grade completed.

High school completion is defined as highest completed grade ≥ 12, college graduation as highest grade completed ≥ 15.

U.S. estimates for high school completion are not reported for parents’ average highest grade completed above 15 because there is no variation in the PSID sample.

Standard errors constructed from 50 and 1,000 bootstraps, respectively.
Figure A23: Local Intergenerational regressions between children’s master degree / highest grade completed and average of parents’ highest grade completed

(a) Master degree, Denmark

(b) Master degree, U.S.

(c) Master degree, U.S.-Denmark difference

(d) Highest grade completed, Denmark

(e) Highest grade completed, U.S.

(f) Highest grade completed, U.S.-Denmark difference

Note: Figures A22a, b, d, and e show local linear regression slopes of children’s education (master degree, highest grade completed) on average of parents’ highest completed grade for Denmark and the U.S. Figures A22c and f show U.S.-Denmark difference in local linear regression slopes between children’s education and parental log gross income including transfers. Master degree is defined as ≥ 17, highest grade completed top-coded at 17. Standard errors constructed from 50 and 1,000 bootstraps, respectively.
B Understanding Trends in Inequality in the U.S. and Denmark

This Appendix investigates the factors leading to the more compressed wage distribution in Denmark compared to the U.S.

B.1 Income

Figure A25 shows trends in wage income and wage income plus public transfers for high school dropouts, high school graduates, and college graduates. In order to facilitate comparisons we use Danish register data and U.S. CPS data. We measure income as wage earnings or wage earnings plus public transfers. Figures A25a, A25b and Figures A25c, A25d show the results for the U.S. and Denmark, respectively. Figures A25a and A25c present the results for the birth cohorts 1927–1958, where income is measured as average income at ages 53 and 54. Figures A25b and A25d present the corresponding results for birth cohorts 1947–1978 using income measured at ages 33 and 34.

The figure shows that in Denmark, wages are more compressed and high school and college premia are not higher during the 1980s than they were 50 years earlier, while schooling premia in the U.S. have more than doubled throughout the same 50 year period. Figure A25a shows that, in the U.S., wage income for individuals with no high school has decreased substantially.

Figures A34 and A35 depict the corresponding evolutions by gender. The figures confirm that the trends described in this section are shared by both sexes and not driven by women’s increased labor force and employment rates.

We construct the samples using similar definitions for both countries. For Denmark, we use administrative register data with information on income and education measured at ages 53–54 for the cohorts born in 1927–1958 (because the Danish data is only available from 1980 and onwards), and income and education measured at ages 33–34 for the cohorts born in 1947–1978. Each cohort contains around 50,000–70,000 individuals. For the U.S., we use CPS data for civilian, non-institutionalized citizens aged 33–34 and 53–54 in each wave. We obtain samples consisting of 116,604 individuals from the 1927–1958 cohorts and 169,860 individuals from the 1947–1978 cohorts. For the Danish data, we measure the income for the former group at ages 53–54 and for the latter group at ages 33–34 in the CPS data.

Figure A25 contains several limitations: that they are not causal estimates and that they do not measure income at the same age, among others. Hence, Figures A25a and A25c may capture both a generation effect and changes that have happened later in their life, while A25b and A25d only incorporate the former mechanism.
between the birth cohorts 1927 and 1958, while high school and college graduates’ income has increased; the high school premium doubled and the college premium increased by 25–30% over this 30 year period. Figure A25b shows that income for high school dropouts and graduates stagnated for later cohorts in the U.S., while college graduates’ income levels increased by 20–30%. Thus, the difference between high school dropouts’ and college graduates’ income measured at ages 33–34 has increased by 50% from the 1947 cohort to those born in the late 1970s. For Denmark, we see a different evolution across the same cohorts. From Figure A25c we see that income levels increased monotonically from cohorts born during early 1930s to the early 1950s. The increases were relatively larger for high school dropouts in earlier cohorts, while for later cohorts (Figure A25d), only high school graduates experienced an absolute and relative income increase. Hence, from cohorts 1927 to 1958, the least educated experienced a large absolute and relative increase in income, while recently high school premia have risen 50–75% and college premia have stagnated.

The evolution in income should be viewed relative to the evolution in employment rates (which we will show in Figure A32). As employment rates of high school dropouts in the U.S. have remained relatively constant, the lower income levels suggest that the reduction stems from lower wages, whereas the corresponding employment rates in Denmark dropped by 30% from 1955 to 1985. Yet high school dropouts’ average wage income only decreased by 10%, implying that their wage rates increased.

Also, Figures A28a and A28b show wage income and wage income plus public transfers at age 26 for high school dropouts by levels of cognitive and non-cognitive skills. Income levels in Denmark, irrespective of skills, are substantially above U.S. levels. Hence, the cross-country difference is not driven by low incomes for the very least skilled U.S. high school dropouts, but rather an overall level difference.

Finally, Figures A25a and A25b also illustrate the schism in levels of public benefits between the U.S. and Denmark. In the U.S., income levels hardly differ by whether we include or exclude public transfers from income, but they substantially affect the results for
Denmark. As seen from Figures A25c and A25d, public transfers constitute an increasing fraction of income in Denmark, in particular for individuals who have not completed high school. Here, average wage earnings decreased by 10% from the 1947 birth cohort to the 1978 birth cohort, while wage earnings plus public transfers increased by 10%.
Figure A24: Wage earnings and wage earnings plus public transfers levels by education, cohorts 1947–1978

(a) U.S., cohorts 1947–1978

(b) Denmark, cohorts 1947–1978

Note: Figures show levels of income from wage earnings and wage earnings plus public transfers by education. Income is measured at ages 33–34. Figures constructed from Danish administrative register data and U.S. March Current Population Survey (CPS, 1981–2011) from Integrated Public Use Microdata Series (IPUMS). Less than high school/high school dropout: less than 12 years of schooling; High school graduates: 12–14.9 years of schooling; College graduates: 15 + years of schooling.
Figure A25: Wage earnings and wage earnings plus public transfers by education, cohorts 1927–1958

(a) U.S., cohorts 1927–1958

(b) Denmark, cohorts 1927–1958

Note: Figures show levels of income from wage earnings and wage earnings plus public transfers by education. Income is measured at ages 53–54. Figures constructed from Danish administrative register data and U.S. March Current Population Survey (CPS, 1981–2011) from Integrated Public Use Microdata Series (IPUMS). Less than high school/high school dropout: less than 12 years of schooling; High school graduates: 12–14.9 years of schooling; College graduates: 15+ years of schooling.
Figure A26: Evolution of schooling premiums at ages 33–34, cohort 1947–1985, indexed

(a) Gross income excl. public transfers
(b) Gross income incl. public transfers
(c) Wage income
(d) Net-of-tax income

Note: In the figures are high school dropout levels indexed relative to the respective difference from high school dropout level from cohort of 1947, and high school and college graduates indexed relative to the high school/college premium in cohort of 1947. Figures are constructed using levels of income from wage earnings and wage earnings plus public transfers by education. Income is measured at ages 33–34.
Figure A27: Evolution of schooling premiums at ages 53–54, cohort 1927–1958, indexed

(a) Gross income excl. public transfers

(b) Gross income incl. public transfers

(c) Wage income

(d) Net-of-tax income

Note: In the figures are high school dropout levels indexed relative to the respective difference from high school dropout level from cohort of 1947 and high school and college graduates indexed relative to the high school/college premium in cohort of 1947. Figures are constructed using levels of income from wage earnings and wage earnings plus public transfers by education. Income is measured at ages 53–54.
Figure A28: Income by cognitive and non-cognitive skills, for high school dropouts

(a) Wage income, U.S.  
(b) Wage income, Denmark

(c) Wage income + public transfers, U.S.  
(d) Wage income + public transfers, Denmark

Note: Figures constructed using data from the CNLSY for the U.S. and administrative register data for Denmark. The figures show levels of wage income at age 26 for high school dropouts in the U.S. and Denmark, by levels of cognitive and non-cognitive skills. For the U.S., we measure cognitive skills by PIAT scores and non-cognitive skills by BPI scores (antisocial, headstrong, and hyperactive domains.) For Denmark, we use exam grades on math and physics to estimate cognitive skills and grades on organization/neatness to estimate non-cognitive skills. In both countries, we measure income at age 26. Colors indicate levels of the outcome variable on the z-axis (wage earnings and wage earnings plus transfers). Lighter indicates a lower levels and darker indicates higher level of the outcome.
One may point to the universal child care and educational systems as explanations for the wage difference for low-educated individuals (Esping-Andersen et al., 2012). If the skills for the least educated in Denmark are higher than in the U.S., this may explain the cross-country differences. Yet a more likely mechanism draws on compressed wages arising from welfare policies. Rosen (1997), Edin and Topel (1997), Freeman et al. (2010), and Fredriksson and Topel (2010) discuss a broad range of likely causes and consequences of wage compression in a symposium on the Swedish welfare state and past decades’ reforms while, for example, Aaberge et al. (2000), Pedersen and Smith (2000), and Tranaes (2006) provide similar evidence from Denmark.

Wage floors are determined through different channels in the two countries. In Denmark, a choice has been made (over many decades)⁴ to implicitly introduce a high lower bound of income. Individuals who cannot meet the corresponding minimum productivity level receive the equivalent by public benefits, work in publicly subsidized jobs, or, as Figure A32 below suggests, become employed in public sector jobs. This is very different from the U.S. system.

Tranaes (2006) briefly discusses and compares the lower bounds of wages between Denmark and the U.S.⁵ In the U.S., minimum wages set the wage floor with only small compensation rates for the least skilled individuals whose productivity falls below this (low) threshold. In Denmark, the wage floor is determined by the levels of public benefits. Figure A29 illustrates this and the general wage compression in Denmark.

Figure A29a shows the U.S. cumulative density of hourly wages conditional on employment

⁴Present day’s labor market in Denmark is the result of a long series of policies which include:

- The September accord, 1899 (September forliget), set the base and rules governing collective bargaining.
- The unemployment insurance law of 1907 (Den Danske Lov om Arbejdsløshedskasser, 9. April 1907). The bill introduced private UI funds to insure employees. The compensation paid by the funds was (and continues to be) heavily subsidized. The core elements of the law remain today.
- The social reform of 1933 which was a collective of bills: Lov om Arbejdsmæssig og Arbejdsmæssigforsikring (U.I.), Lov om offentlig Forsorg (welfare benefits), Lov om Folkeforsikring (health care coverage), Lov om Forsikring mod Følger af Ulykker (occupational injuries).
- The public sector expansions during the 1960s and 1970s introducing universal child care/preschools.

⁵We do not wish to argue for or against any mechanisms that drive the increasing schooling premia in the U.S., but only outline the core differences in the lowest wage level between the two countries.
and the federal minimum wage rate for individuals aged 25–59 in 2006. Likewise, Figure A29b (Figure 1.1 from Tranæs, 2006) illustrates that the levels of public benefits serve as a wage floor in Denmark. The figure shows the cumulative distribution of mean hourly wages conditional on employment and the cumulative distribution of self-rated hourly wage potential for Danes aged 25–59 in 2006.

The figures show that only very few report wage rates below the minimum wage in the U.S. and that none work in jobs with hourly wages below the hourly wage equivalent of highest rate of social assistance in Denmark.\(^6\) On the one hand, by comparing the two figures it is evident that there is a substantial mass of individuals in the U.S. that earn less than the wage floor in Denmark; around 15% of U.S. incomes fall below the Danish level of social assistance. On the other hand, the mass of high wage rates are higher in the U.S. than in Denmark. Virtually all Danes earn below DKK 300 per hour while approximately 5% of U.S. wage earners have hourly wages that are higher. Moreover, a sizeable fraction in Denmark rate their own productivity lower than the lowest observed level of hourly wages. However, jobs paying wages below this threshold have been eradicated, likely across many decades (which also made minimum wages set by law superfluous), because social assistance is means tested (deducted 1:1 from any wage earnings).\(^7\) Thus, any returns to work below the level of benefits are nullified.

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\(^6\)For immigrants in Denmark, who are often not entitled to unemployment benefits (as many are uninsured), the wage floor is set by the level of social assistance instead.

\(^7\)The reason was a fear that public benefits might otherwise result in a downwards wage push.
Figure A29: Wage floors in Denmark and the U.S., hourly wages

(a) Actual hourly wages in the U.S.

(b) Actual/potential hourly wages in Denmark

Note: Figure A29a shows cumulative density of hourly wage rates in the U.S. using Merged Outgoing Rotation Groups (MORG) 2006 and the federal minimum wage rate from: http://www.dol.gov/whd/minwage/chart.htm. Figure A29b (Figure 1.1 from Tranæs, 2006, pp. 21) shows hourly wage rates and self-rated potential hourly wage rates for non-immigrants aged 25–59. The vertical dashed line marks the 2006 hourly wage equivalent of the levels of social assistance for a single full-time recipient, without children, aged 25 or above. The vertical solid line marks the 2006 hourly wage equivalent of the levels of social assistance for a full-time recipient with children, aged 25 or above. All numbers in Figure A29b are in 2006 DKK.

B.2 Educational Transitions

We now examine trends in transition matrices of father’s to children’s educational levels. Thus, we also obviate the problems that might arise from nonequivalence of highest grade completed. Transition matrices are estimated across birth cohorts from 1955–1985 and presented in Figure A30.

Figures A30a and A30b show that the fractions of children who have not completed high school, conditional on father’s education, are roughly constant across the 30 year period. But the seemingly constant rate masks strong underlying trends. From Figure A30e we see that rates of college completion are almost unchanged for children from high school dropout fathers, whereas college completion rates have doubled for children of fathers who had completed college themselves. In conclusion, the figures show that past decades’ increases in levels of schooling to a large degree have been driven by children from college-educated parents, to a small degree by children whose parents had high school as highest completed
education, and to a very small extent by children from high school dropouts.

Figures A30b, A30d, and A30f show the corresponding numbers for the U.S. by combining the NLSY79 and NLSY97 data sets. The figures show that the transmission rates in the U.S. were very different from those found in Denmark for the cohorts born in the late 50s and early 60s. Yet the figure also shows that there are only minor cross-country differences for children born in the first half of the 80s. The conditional fractions of high school dropouts have increased while the conditional rates of high school and college completions has decreased, which brings the U.S. level on par with the Danish.

Figure A39 shows trends in regression coefficients from children’s years of schooling on parental years of schooling and parental income rank for Denmark by birth cohort. The figure confirms the pattern from Figure A30e. Estimated coefficients increase monotonically from children born in the late 50s to the late 80s, thus mirroring the strong increase in college graduation rates for children whose fathers had completed college. For the most recent cohorts available, the Danish IGE of schooling is at the level Hertz et al. (2008) report for both Denmark and the U.S.

In conclusion, there are no discrepancies in intergenerational mobility measured by educational transmissions between the U.S. and Denmark when we consider the most recent available cohorts. Hence, educational mobility does not explains differences in intergenerational income mobility between Denmark and the U.S.
Figure A30: Transition, father’s education and child’s education, Denmark and the U.S.

(a) Children with no high school, Denmark

(b) Children with no high school, U.S.

(c) Children with at least high school, Denmark

(d) Children with at least high school, U.S.

(e) Children with college as highest, Denmark

(f) Children with college as highest, U.S.

Note: Figures for Denmark are constructed using full cohorts born between 1955 and 1985 with highest grade completed measured at 27. Figures for the U.S. are constructed using the NLSY79 and NLSY97 samples. Cohorts 1957–1964 are constructed using the NLSY79 and cohorts 1980–1984 are constructed using the NLSY97. The grey lines are illustrative and link the 1964 cohort to the 1980 cohort, and do not necessarily reflect actual trends during that period. No high school/dropout: less than 12 years of schooling; High school: 12–14.9 years of schooling; College: 15 years of schooling or above.
In the analysis above (and others throughout the paper), differences in assortative mating of parents may explain trends and cross-country differences. We do not address these issues directly, but instead refer the reader to Eika et al. (2014) who study this issue in Norway and the U.S. Figure A31 shows trends in educational assortative mating in Denmark. The figure corresponds to Figure 4 in Eika et al. (2014), suggesting that their findings on Norway apply to Denmark as well.

**Figure A31: Trends in educational assortative mating, Denmark**

Note: The figure shows rates of educational assortative mating for equal levels of educational attainment: $AM_{h,w} = \frac{P(\text{educ}_h = i)P(\text{educ}_w = i)}{P(\text{educ}_h = i)P(\text{educ}_w = i)}$, $h$: Husband, $w$: Wife.

Levels of educational attainment are redefined relative to remainder of the paper in order to follow the definitions for Norway in Eika et al. (2014): below high school: years of schooling < 12; high school: years of schooling = 12; some college: years of schooling $\in [12, 25]$; college: years of schooling $\geq 15$. The sample includes all non-immigrant married couples where the average of their age was between 26 and 60 in the year in question (around 1,000,000 couples each year).
B.3 Employment

Figures A32a and A32b show rates of employment and labor force participation at age 26 for high school dropout by birth cohort. Figure A32a shows that employment rates in Denmark dropped from around 0.75 for the 1955 cohort to around 0.55 for the 1985 cohort. In Figure A32b we see an even steeper reduction when we consider rates of labor force participation for high school dropouts in Denmark from around 90% in the 1955 cohort to only 60% in the 1985 cohort. Figure A32c illustrates that the corresponding numbers in the U.S. have been stable over the period depicted. Hence, for U.S. children born in the late 1950s and early 1960s, employment and labor force participation rates for high school dropouts were around 20%-points lower than those in Denmark, but for the 1980 birth cohorts, the U.S. and Danish rates were at very similar levels. Thus, overall rates of employment and labor force participation may have added to social mobility in Denmark relative to the U.S. in previous decades, but this does not seem to be the case for recent years.

Figures A32c and A32d present occupational trends measured at age 26 for high school dropouts and individuals who have high school as highest completed education. Figure A32c shows that for high school dropouts in Denmark, the share of employment in welfare occupations as share of total employment has quadrupled over a 20 year period. Many of the tasks in the Danish welfare sector are performed by stay-at-home moms, other family members (non-market agents), or private institutions in the U.S. which may affect female labor supply (Kolm and Lazear, 2010), if not only crowding out informal non-parental care (Havnes and Mogstad, 2011).
cohort for the U.S. The trends and levels in the U.S. are very different from those in Denmark. Rates of employment in welfare-related occupations are almost 30%-points lower than in Denmark and rates of manual or production work is around 10-20%-points higher than in Denmark, albeit gradually declining. Also, work in sales/services is around 10%-points above the Danish level.

In conclusion, the figures emphasize that a large and rapidly increasing fraction of the least educated are working with some of Scandinavian welfare states’ core tasks. As earnings differentials are smaller than in the private sector (see, e.g., Pedersen et al., 1990; Zetterberg, 1990), a large public sector share of total employment may in itself contribute to lower inequality (Aaberge et al., 2002).¹⁰

Additionally, wage compression as shown in Figures A25–A29 may also explain the underlying mechanisms in educational and employment patterns. As incentives to educate decrease along with returns to education (Fredriksson and Topel, 2010), initial equating mechanisms from early education might be offset by later distortions, thereby putting educational mobility in Denmark and the U.S. back on par (see Sections 1 and 3.3, and Figure A32 in this section). Moreover, Rosen (1997) and Edin and Topel (1997) argue that public employment is the main driver of overall employment rates, because wage compression is associated with close to constant private employment rates. This could result in the occupational patterns seen in Figure A32, where we show that almost 40% of Danish high school dropouts with employment work in public welfare jobs.

¹⁰In 2013, the public sector share of total employment was 35% in Denmark and 14% in the U.S.
Figure A32: High school dropouts’ labor market attachment at age 26

(a) Employment and labor force participation rates, Denmark
(b) Employment and labor force participation rates, U.S.
(c) Occupations, Denmark
(d) Occupations, U.S.

Note: Figure (a) constructed from administrative register data on cohorts born 1955–1985 and their parents in Denmark. Figure (b) constructed from March Current Population Survey (CPS, 1981–2011) from Integrated Public Use Microdata Series (IPUMS). The sample consists of civilian, non-institutionalized citizens at age 26 in each wave. Number of observations used to create the chart is 74,562 (of whom 9,949 were high school dropouts). Employment is defined as being at work or being absent from work but having a job during the time preceding the interview week. Labor Force Participation is defined as being employed or actively looking for a job during the time preceding the interview week. Less than high school/high school dropout: less than 12 years of schooling, High school graduates: 12–14.9 years of schooling, College graduates: 15 + years of schooling.
It may not be possible to reproduce this mechanism in other contexts. The Scandinavian countries are small and demographically homogeneous in comparison with the U.S. and even other European countries. Large transfers, wage compression, and a large welfare sector, financed through heavy taxation as means to increase minimum standards of living, might not be a viable road to follow for the U.S.. Indeed, foreigners often look to Scandinavia wondering how such high levels of taxation can be combined with tax compliance and economic activity. Kleven (2014) investigates and discusses this paradox, and he emphasizes close to full third-party information of income to tax authorities (maximizing tax compliance) and broad tax bases to avoid tax avoidance, together with large public spendings that focus on complementing work as essentials.
B.4 Supplementary Figures to *Understanding Trends in Inequality in the U.S. and Denmark*

Figure A33: Trends in mother’s, father’s, and children’s education, cohort 1955–1985, Denmark

(a) Mothers  
(b) Fathers  
(c) Children

*Note:* Figures show mean levels of education by birth cohort in Denmark.
Figure A34: Trends in wage income returns to schooling by gender, Denmark

(a) Evolution of income differences at ages 53–54, males, cohort 1927–1958

(b) Evolution of income differences at ages 33–34, females, cohort 1927–1948

(c) Evolution of income differences at ages 33–34, males, cohort 1947–1978

(d) Evolution of income differences at ages 33–34, females, cohort 1947–1978

Note: In the figures are high school dropout levels indexed relative to the respective difference from high school dropout level from cohort of 1947, and high school and college graduates indexed relative to that high school/college premium in cohort of 1947.
Figure A35: Trends in wage plus public benefit returns to schooling by gender, Denmark

(a) Evolution of income differences at ages 53–54, males, cohort 1927–1958

(b) Evolution of income differences at ages 53–54, females, cohort 1927–1948

(c) Evolution of income differences at ages 33–34, males, cohort 1947–1978

(d) Evolution of income differences at ages 33–34, females, cohort 1947–1978

Note: In the figures are high school dropout levels indexed relative to the respective difference from high school dropout level from cohort of 1947, and high school and college graduates indexed relative to that high school/college premium in cohort of 1947.
Figure A36: Evolution of schooling premiums at ages 53–54, cohort 1927–1958

(a) U.S., wage earnings

(b) U.S., wage earnings + public benefits

(c) Denmark, wage earnings

(d) Denmark, wage earnings + public benefits

Note: In the figures are high school dropout levels indexed relative to the respective difference from high school dropout level from cohort of 1947, and high school and college graduates indexed relative to that high school/college premium in cohort of 1947. Figures are constructed using levels of income from wage earnings and wage earnings plus public transfers by education. Income is measured at ages 53–54 in Figures a and c and at ages 33–34 in Figures b and d. Figures constructed from Danish administrative register data and U.S. March Current Population Survey (CPS, 1981–2011) from Integrated Public Use Microdata Series (IPUMS). Less than high school/high school dropout: less than 12 years of schooling; High school graduates: 12–14.9 years of schooling; College graduates: 15 + years of schooling.
Figure A37: Evolution of schooling premiums at ages 33–34, cohort 1947–1978

Note: In the figures are high school dropout levels indexed relative to the respective difference from high school dropout level from cohort of 1947, and high school and college graduates indexed relative to that high school/college premium in cohort of 1947. Figures are constructed using levels of income from wage earnings and wage earnings plus public transfers by education. Income is measured at ages 53–54 in Figures a and c and at ages 33–34 in Figures b and d. Figures constructed from Danish administrative register data and U.S. March Current Population Survey (CPS, 1981–2011) from Integrated Public Use Microdata Series (IPUMS). Less than high school/high school dropout: less than 12 years of schooling; High school graduates: 12–14.9 years of schooling; College graduates: 15 + years of schooling.
Figure A38: Evolution of average wage earnings at age 26 for high school dropouts by occupation, cohort 1965–1985

Figure A39: Coefficients of intergenerational associations, Denmark

(a) Parental income rank, child’s highest grade completed

(b) Parental highest grade completed, child’s highest grade completed

Note: Figures show regression coefficients—for each of the cohorts born in Denmark between 1965 and 1983—of child’s highest grade completed measured at age 30 regressed on (a) parental income rank measured when third child was 25 and (b) parents’ highest grade completed.

C Income Metrics and Rank-Rank Estimations of Intergenerational Mobility

The results reported in the text indicate that choice of outcome and income metric could affect the size and curvature of the parent-child associations. Using dummy variables as outcomes has likely made the results and curvature differ particularly much between two aspects of schooling, because the margins of variation are largely limited to certain regions of the income distributions. In this subsection we now turn our attention to the potential impact of different income metrics and wage compression for parents. In order to elucidate this particular point we will focus on non-binary outcomes (income and years of schooling), and use data from earlier cohorts in the Danish register data. We use data on all children born in Denmark between 1973 and 1979 who had not died or migrated before 2012. Also, both of the children’s parents should be known and alive at least until the child’s 15th year.
This results in a sample of around 410,000 child-parent pairs. We measure children’s income as a three year average of income from 2010 to 2012 (from ages 31–33, ..., 37–39) and parental income as a nine year average of mother’s and father’s income from the child’s 7th to 15th year (years 1980–1988, ..., 1987–1995).

We consider the five different income metrics from the main paper: gross income excluding public transfers, total gross income including public transfers, wage earnings, wage earnings and public transfers, and total net-of-tax income. Figure A40a shows example scatterplots of children’s average income rank by bins of parental income percentiles. Likewise, Figure A40b shows scatterplots of children’s average years of schooling by bins of parental income percentiles. The figures show that there is little difference between the pattern of the parent-child associations between outcomes, but substantial differences between income metrics in the tails of parental income distributions, the lower tail in particular. While there are few differences shown by measuring parental income as gross income or net-of-tax income, large gaps exist between wage earnings and the other two income metrics.

Table A17 shows the corresponding rank-rank and rank-schooling regression coefficients together with the estimated ‘extremum-slope’ slope between the 1st and 100th percentiles. Rank-rank slopes increase by 25% to around 0.25–0.27 when we consider gross income instead of wage earnings. Likewise, the slope between parental income rank and child’s years of schooling increase range between 0.017 to 0.027 depending on income metric of choice. The differences become even more striking for the extremum-slopes between the 1st and 100th percentile which differ by as much as 75%.
Figure A40: Differences in rank slopes by income measures, Denmark

(a) Rank-rank of child and parental income by dif. income measures

(b) Child’s highest grade completed by ranks from dif. parental income measures

Note: Figures show mean of child’s income rank and children’s highest grade completed by bins of parental income percentiles. Income is measured either as wage income or gross income including capital income (9 year averages measured when child was aged 7–15). In Figure a, children’s income (3 year averages from ages 37–39) is measured by the same income measure as parents’ income. Zero wage earnings are not randomized into the rank distribution.
Table A17: Intergenerational correlations between income and years of schooling, and various parental income, Denmark metrics

<table>
<thead>
<tr>
<th></th>
<th>Gross income excl. public transfers</th>
<th>Gross income incl. public transfers</th>
<th>Wage earnings</th>
<th>Wage earnings and public transfers</th>
<th>Net-of-tax total gross income</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Child income rank</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rank-income slope</td>
<td>0.273*** (0.002)</td>
<td>0.253*** (0.002)</td>
<td>0.205***</td>
<td>0.177*** (0.002)</td>
<td>0.229*** (0.002)</td>
</tr>
<tr>
<td>Slope from 1–100</td>
<td>0.398*** (0.010)</td>
<td>0.332*** (0.0010)</td>
<td>0.216***</td>
<td>0.170*** (0.001)</td>
<td>0.271*** (0.0010)</td>
</tr>
<tr>
<td><strong>Child years of schooling</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rank-schooling slope</td>
<td>0.027*** (0.0001)</td>
<td>0.025*** (0.0001)</td>
<td>0.020***</td>
<td>0.017*** (0.0001)</td>
<td>0.022*** (0.0001)</td>
</tr>
<tr>
<td>Slope from 1–100</td>
<td>0.037*** (0.001)</td>
<td>0.030*** (0.001)</td>
<td>0.020***</td>
<td>0.015*** (0.001)</td>
<td>0.023*** (0.001)</td>
</tr>
</tbody>
</table>

Note: Table shows difference from p1 to p100 from Figure A40a.
*: \( p < 0.1 \), *: \( p < 0.05 \), **: \( p < 0.01 \), ***: \( p < 0.001 \).

Figures A41a and A41b show the slopes corresponding to the rank-rank and rank-schooling plot from Figure A40. As evidenced by the previous figure, the slopes from wage earnings and total gross income, and net-of-tax income are highly different. For both outcomes, the slope is negative or zero at the lowest quintile of parental income when measuring this as wage earnings. In contrast, the two other income metrics result in slopes which are at their steepest point in the bottom of the distributions. There is no difference between the parent-child between the 20th and the 80th percentile, while at the top of the income distributions the slopes diverge again. Here, the slope of wage earnings is higher than that of gross income or net-of-tax income. The underlying reason is evident from Figures A41c and A41d. Figure A41c shows the distribution of the three income metrics and A41d shows the step size from one percentile in the income distribution to the next measured in DKK. The figure shows the difference between the lowest income in the 10th percentile and the lowest income in the 11th percentile. The figures show that, in absolute terms, differences between the lowest percentiles of the wage earnings distribution are zero (or even not identified in the case of many zero-earners), while it is higher than 50,000 DKK (approximately 9,000 USD) for gross
income and net-of-tax income. Likewise, the step sizes increase substantially for all of the income metrics in the upper tail of the income distribution which reflect the long tail of high incomes.

**Figure A41: Slopes, distributions, and absolute differences between percentiles by different income measures, Denmark**

(a) Slope, rank-rank of income, 
(b) Slope, child’s HGC-parental income rank,  
(c) Densities income distributions  
(d) Step size from percentile n to n+1  

Note: Figures show slopes (a–b), income distributions (c), and step sizes from percentile n to n+1 (d), for wage income and total gross income (including capital income).

The results presented in this section are not to be taken as universally applicable results
as they likely arise from the specific income distributions, wage compression, and level of public transfers in Denmark. Still, the results highlight how income distributions affect shapes and even magnitudes of intergenerational comparisons. A key finding is that the potential impacts are largest at the bottom of the income distributions (at least when we consider rank/percentiles of income). This is particularly important because it shows that estimates like intergenerational income elasticities depend highly on income distribution, and potentially also on the fraction of individuals who have spells where they have zero earnings. Hence, estimates of IGE may be mechanically reduced as unemployment rates increase, even when public benefits are included, because convexity increases with the fraction of zero earners.
Figure A42: Life cycle bias: rank-rank slopes by age of child, Denmark

(a) Varying age at which child’s income is measured

(b) Varying age at which child’s and parents’ income is measured

Note: These figures correspond to Fig III A presented in Chetty et al. (2014, pp. 1579). Figure A shows OLS coefficients of child’s income rank within own cohort on parental income rank by different ages of measurement. Each measurement is a two year average of children’s income and a four year average of parental income. Children’s income is measured at age t and t+1 (such that the point at, e.g., age 25 corresponds to average income of age 25 and 26) whereas parental income is an average of income measured between ages 15 and 18 of the child. We use the cohort of children born in Denmark in 1965 who have any reported income at some point between 1980 and 2012. Also, children need to have both a mother and father identified in the registers from 1980 to 1983. The resulting sample is 50,473.

Figure B shows the difference between OLS coefficients of rank-rank regressions when both parental income and child’s income is measured at different ages of the child. Each measurement is a two year average of children’s income and a four year average of parental income. Children’s income is measured at age t and t+1 (such that the point at, e.g., age 25 corresponds to average income of age 25 and 26) whereas parental income is an average of income measured between ages 10 and 13/20 and 23 of the child. As we do not have income data for earlier than 1980, we use the cohort born in 1970 to gain information on parental income from the year the child turned 10. The same data limitation applies as in Figure A, which results in a sample of 52,591 individuals.
Figure A43: Attenuation bias: rank-rank slopes by number of years used to measure parental income and by different income measures

(a) Using data from earlier years and adding later years

(b) Using data from later years and adding earlier years

Percent ‘bias’ using two years of parental income relative to using permanent income (12 year average)

<table>
<thead>
<tr>
<th>Parents’ income measured:</th>
<th>Age 5–7</th>
<th>Age 18–20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wage earnings:</td>
<td>0.32</td>
<td>0.03</td>
</tr>
<tr>
<td>Wage earnings incl. UI/welfare:</td>
<td>0.15</td>
<td>0.00</td>
</tr>
<tr>
<td>Total gross income:</td>
<td>0.12</td>
<td>0.03</td>
</tr>
<tr>
<td>Total net-of-tax income:</td>
<td>0.14</td>
<td>0.02</td>
</tr>
<tr>
<td>Observations</td>
<td>163,672</td>
<td>163,672</td>
</tr>
</tbody>
</table>

Note: These figures correspond to Fig III B presented in Chetty et al. (2014, pp. 1579). Figures A and B show OLS coefficients of child’s income rank within own cohort on parental income rank by how many years of income data used to define parent’s income. In Figure A, we measure parental income when the child was 5 to 7 years old (depending on cohort) and gradually add subsequent years of income data. In Figure B, we use income data from the year the child turned 17 to 19 (depending on cohort) and gradually add income data for preceding years. We measure children’s income as average of income from 2010 to 2012. We use the full cohorts in Denmark born between 1973 and 1975 and limit the data to those who have any reported income between 2010 and 2012, and the children need to have both a mother and father identified in the registers from 1980 to 1990. The resulting sample is 163,672.
D Note on Rank-Regression

This note follows the estimation procedure and outline of rank-regression from Sawyer (2009). We consider a paired data \((Y_i, X_i)\), which in the present case is children’s and parent’s income (or the log of). The objective is to estimate a one-dimensional \(\beta\) in the following equation:

\[
Y_i = \mu + \beta X_i + e_i. \tag{D.1}
\]

A vast number of estimators of \(\beta\) exists. The modal statistic, the *ordinary least squares* estimator, is found by minimizing the square of residuals, thus weighing extreme observations relatively high. An alternative, the *rank-regression* estimate, is found by minimizing the product of ranked residuals, thus putting less weight on extreme observations and more weight on mid-rank observations.

In practice, the rank-regression estimator is the result of a minimization of the sum of the product of residuals \((Y_i - \beta X_i)\) and centered ranks of residuals \((R^c_i(\beta))\):

\[
\min_{\beta} D(\beta) = \sum_{i=1}^{n} R^c_i(\beta)(Y_i - \beta Y_i) \\
= \sum_{i=1}^{n} (R_i(\beta) - (n + 1)/2)(Y_i - \beta Y_i), \tag{D.2}
\]

where \(R_i(\beta)\) is the rank of \(Y_i - \beta Y_i\) among all \(Y_i - X_i\). Moreover, we can subtract any constant, thus obviating \(\mu\), because the sum of the mid-rank (centered rank) \(R_i(\beta) - (n + 1)/2\) across all individuals is zero by construction. The slopes between each \((X_j, X_i)\) (for \(X_j \neq X_i\)) can be defined as \(\beta_{ij} = (Y_j - Y_i)/(X_j - X_i)\). We now define the sorted slopes—from the lowest to the highest—as:

\[
\{W_k : 1 \leq k \leq N\} = \frac{Y_j - Y_i}{X_j - X_i} : 1 \leq i < j \leq n \text{ and } X_j \neq X_i. \tag{D.3}
\]

Our objective is to estimate the minimum of \(D(\beta)\), i.e., where the derivative of \(D(\beta)\) is
zero. The order of the residuals $Y_i - \beta X_i$ will be the same as the order of the $X$’s for values below the $\beta$ that minimizes $D(\beta)$, and the opposite order for values above. Define $Q$ as:

$$Q = \sum_{i=1}^{n} R_i(X)X_i > 0$$

(D.4)

where $X_i$ is not constant. Define the initial slope of $D(\beta)$ between $W_0, W_1$ as $S_0 = -Q$ and all subsequent $S_k$’s as:

$$S_k = -Q + \sum_{p=1}^{k} |X_{jp} - X_{ip}|.$$  

(D.5)

From the construction of $Q$ and $S_k$, the slope $W_k$ that minimizes $D(\beta)$ is given by the $S_k$ that satisfies:

$$k_0 = \text{min} \{k : S_k > 0\}$$

(D.6)

for $1 \leq k \leq N$, because the product of residuals and ranks of residuals will be increasing on each side of this point $k_0$. The rank-regression estimate $\hat{\beta}$ will be given as:

$$\hat{\beta} = W_{k_0} = \frac{Y_{j_{k_0}} - Y_{i_{k_0}}}{X_{j_{k_0}} - X_{i_{k_0}}} \text{ if } S_{k_0-1} < 0 < S_{k_0}.$$  

(D.7)

In practice, we estimate $\beta$ by drawing a random sample of the full data as the calculating and sorting for all individual difference quotients. We estimate standard errors from 50 bootstraps.

### E  Note on Empirical Copulas

A copula is a multivariate probability distribution which we employ to describe the dependence between children’s and parents’ income. The foundation for copulas arise from Sklar’s theorem stating that an $n$-dimensional distribution function $F$ can be divided into two distinct terms:

---

11$k$ is the sorted rank of slopes which we sum over until 0. $p$ is the individual observations from the first to the $p$th observation. So for $k = 3$, we have $|X_{j_1} - X_{i_1}| + |X_{j_2} - X_{i_2}| + |X_{j_3} - X_{i_3}|$. In the way $Q$ is defined, this sum will equal $Q$ at the median sorted observation.

12In the special case where $S_{k_0-1} = 0$, the estimate $\hat{\beta} = \frac{W_{k_0-1} - W_{k_0}}{2}$. 

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the marginal distribution functions $F_i(x) = P(x_i \leq x)$ and the copula $C$:

$$F(x_1, \ldots, x_n) = C(F_1(x_1), \ldots, F_n(x_n)).$$ (E.1)

In the case with two continuous variables (income) $X_1$ and $X_2$, the copula $C(u, v)$ will be $P(U \leq u, V \leq v)$. This is useful in the present case of describing the dependence between parental and children’s income, because the tail dependence in income distributions is notoriously difficult to determine.

In practice, we estimate the (nonparametric) empirical copulas. By taking the empirical distribution:

$$F_{i,j}(x) = \frac{1}{N} \sum_{i=1}^{N} 1(X_{i,j} \leq x), \ i = 1, \ldots, N ; \ j = 1, 2,$$ (E.2)

and the corresponding copula $(\hat{U}, \hat{V})$, we can define the empirical copula as:

$$\hat{C}(u, v) = \frac{1}{N} \sum_{i=1}^{N} 1(\hat{U}_i \leq u, \hat{V}_i \leq v).$$ (E.3)

One straightforward way of writing $\hat{U}$ and $\hat{V}$ is as the rank of each observation $R_i(X_i)$. Hence, the empirical copula becomes the empirical distribution of children’s and parents’ income ranks.

In the graphical presentation of the copula results in Figures A44–A47, we replace each income rank $R_i(X_i)$ by the minimum income level within each rank in order to obviate the undesirable attribute of income ranks: that they are detached from actual income levels.
Figure A44: Gross income excluding public transfers, empirical copula

Note: The figures show empirical copulas defined as the joint empirical distribution of rank-transformed data, and each cell corresponds to the marginal rank distribution. In the figures, x-axis and y-axes, ranks have been transformed to levels using the within percentile \( \text{min}(\text{Income}) \). Figure A44a shows the copula in a 3-dimensional plot and Figure A44b shows the same copula as a 2-dimensional heatmap. The figures (colors and z-axis) depict the copula densities, which illustrate the (non-linear) intergenerational dependence of income across levels of parents and children’s income. Going from green to blue, there is a weaker intergenerational dependence of income (lower density). Going from green via yellow to red, there is a stronger intergenerational dependence of income (higher density). The figure shows that the strongest dependence is present in the tails at high-high and low-low values of income as opposed to mid-range income levels. For a further description of copulas, see Web Appendix E.
Figure A45: Gross income including public transfers, empirical copula

Note: The figures show empirical copulas defined as the joint empirical distribution of rank-transformed data, and each cell corresponds to the marginal rank distribution. In the figures’ x-axis and y-axis, ranks have been transformed to levels using the within percentile \( \min(Income_i) \). Figure A45a shows the copula in a 3-dimensional plot and Figure A45b shows the same copula as a 2-dimensional heatmap. The figures (colors and z-axis) depict the copula densities, which illustrate the (non-linear) intergenerational dependence of income across levels of parents and children’s income. Going from green to blue, there is a weaker intergenerational dependence of income (lower density). Going from green via yellow to red, there is a stronger intergenerational dependence of income (higher density). The figure shows that the strongest dependence is present in the tails at high-high and low-low values of income as opposed to mid-range income levels.

For a further description of copulas, see Web Appendix E.
Figure A46: Wage income and public transfers, empirical copula

(a) 3D Copula

(b) Copula heatmap

Note: The figures show empirical copulas defined as the joint empirical distribution of rank-transformed data, and each cell corresponds to the marginal rank distribution. In the figures’ x-axis and y-axis, ranks have been transformed to levels using the within percentile \( \min(\text{Income}_i) \). Figure A46a shows the copula in a 3-dimensional plot and Figure A46b shows the same copula as a 2-dimensional heatmap.

The figures (colors and z-axis) depict the copula densities, which illustrate the (non-linear) intergenerational dependence of income across levels of parents and children’s income. Going from green to blue, there is a weaker intergenerational dependence of income (lower density). Going from green via yellow to red, there is a stronger intergenerational dependence of income (higher density). The figure shows that the strongest dependence is present in the upper tail at high-high values of income as opposed to low- and mid-range income levels.

For a further description of copulas, see Web Appendix E.
Figure A47: Net-of-tax income including public transfers, empirical copula

(a) 3D Copula

(b) Copula heatmap

Note: The figures show empirical copulas defined as the joint empirical distribution of rank-transformed data, and each cell corresponds to the marginal rank distribution. In the figures’ x-axis and y-axis, ranks have been transformed to levels using the within percentile \( \min(\text{Income}_i) \). Figure A47a shows the copula in a 3-dimensional plot and Figure A47b shows the same copula as a 2-dimensional heatmap. The figures (colors and z-axis) depict the copula densities, which illustrate the (non-linear) intergenerational dependence of income across levels of parents and children's income. Going from green to blue, there is a weaker intergenerational dependence of income (lower density). Going from green via yellow to red, there is a stronger intergenerational dependence of income (higher density). The figure shows that the strongest dependence is present in the upper tail at high-high values of income as opposed to low- and mid-range income levels. For a further description of copulas, see Web Appendix E.
Figure A48: Gross income excluding public transfers, copula from actual income, simulated normal distribution

(a) Actual

(b) Bivariate normal distribution

(c) Actual-normal difference

Note: The figures show empirical copulas defined as the joint empirical distribution of rank-transformed data, and each cell corresponds to the marginal rank distribution. Figure (a) shows copulas derived from actual data, Figure (b) shows the copula derived from a simulated bivariate normal distribution with correlation as observed between parents’ and children’s log gross income excluding public transfers (0.246, see Table A5) and median/variance as observed in the actual income data, and Figure (c) shows the level difference between (a) and (b) where a positive value reflects that the actual level is above the simulated normal level. In the figures’ x-axis and y-axis, ranks have been transformed to levels using the within percentile \( \text{min}(Income) \).

Going from green to blue, there is a weaker intergenerational dependence of income (lower density). Going from green via yellow to red, there is a stronger intergenerational dependence of income (higher density). The figures show that the actual intergenerational tail dependence in the data is stronger than what is predicted from a bivariate normal distribution. For a further description of copulas, see Web Appendix E.
Figure A49: Gross income including public transfers, copula from actual income, simulated normal distribution

(a) Actual  
(b) Bivariate normal distribution

(c) Actual-normal difference

Note: The figures show empirical copulas defined as the joint empirical distribution of rank-transformed data, and each cell corresponds to the marginal rank distribution. Figure (a) shows copulas derived from actual data, Figure (b) shows the copula derived from a simulated bivariate normal distribution with correlation as observed between parents’ and children’s log gross income excluding public transfers (0.201, see Table A5) and median/variance as observed in the actual income data, and Figure (c) shows the level difference between (a) and (b) where a positive value reflects that the actual level is above the simulated normal level. In the figures’ x-axis and y-axis, ranks have been transformed to levels using the within percentile \(\text{min}(\text{Income}_i)\).

Going from green to blue, there is a weaker intergenerational dependence of income (lower density). Going from green via yellow to red, there is a stronger intergenerational dependence of income (higher density). The figures show that the actual intergenerational upper tail dependence in the data is stronger than what is predicted from a bivariate normal distribution. For a further description of copulas, see Web Appendix E.
Figure A50: Wage income and public transfers, copula from actual income, simulated normal distribution

(a) Actual

(b) Bivariate normal distribution

(c) Actual-normal difference

Note: The figures show empirical copulas defined as the joint empirical distribution of rank-transformed data, and each cell corresponds to the marginal rank distribution. Figure (a) shows copulas derived from actual data, Figure (b) shows the copula derived from a simulated bivariate normal distribution with correlation as observed between parents’ and children’s log gross income excluding public transfers (0.094, see Table A5), and Figure (c) shows the level difference between (a) and (b) where a positive value reflects that the actual level is above the simulated normal level. In the figures’ x-axis and y-axis, ranks have been transformed to levels using the within percentile $\min(\text{Income}_i)$. Going from green to blue, there is a weaker intergenerational dependence of income. Going from green via yellow to red, there is a stronger intergenerational dependence of income. The figures show that the actual intergenerational upper tail dependence in the data is stronger than what is predicted from a bivariate normal distribution. For a further description of copulas, see Web Appendix E.
Figure A51: Net-of-tax income including public transfers, copula from actual income, simulated normal distribution

(a) Actual

(b) Bivariate normal distribution

(c) Actual-normal difference

Note: The figures show empirical copulas defined as the joint empirical distribution of rank-transformed data, and each cell corresponds to the marginal rank distribution. Figure (a) shows copulas derived from actual data, Figure (b) shows the copula derived from a simulated bivariate normal distribution with correlation as observed between parents’ and children’s log gross income excluding public transfers (0.174, see Table A5), and Figure (c) shows the level difference between (a) and (b) where a positive value reflects that the actual level is above the simulated normal level. In the figures’ x-axis and y-axis, ranks have been transformed to levels using the within percentile \( \min(\text{Income}_i) \).

Going from green to blue, there is a weaker intergenerational dependence of income. Going from green via yellow to red, there is a stronger intergenerational dependence of income. The figures show that the actual intergenerational upper tail dependence in the data is stronger than what is predicted from a bivariate normal distribution while the lower tails is a little weaker than what is predicted from a bivariate normal distribution.

For a further description of copulas, see Web Appendix E.
F  Data Appendix

This section describes the data sources and the main variables used for the analysis in the main text and in the Web Appendix. For the U.S., we use data from the CPS, NLSY79, CNLSY, NLSY97, and PSID, and for Denmark we use Danish full population administrative register data. This section consists of three parts. First, we describe the U.S. data sources and samples, second we describe the Danish data sources and samples, and finally, we provide summary statistics.

F.1  U.S. Data

We use data from the NLS surveys. They are nation-wide surveys for fixed panels, sponsored by the U.S. Bureau of Labor Statistics. The NLS surveys follow representative populations (or their children) in annual or biannual surveys.\(^\text{13}\) Data on a wide range of areas are collected, including education, income, demographic characteristics, family relations, labor market outcomes, cognitive test scores, behavioral questionnaires, crime outcomes, and health, among others. Second, we use data from the Current Population Survey, a monthly survey of households conducted by the Bureau of Census for the Bureau of Labor Statistics.\(^\text{14}\) It provides cross-sectional information on education, income, labor market outcomes, and demographic characteristics, among others. We use annual information from the March CPS from 1980 to 2011.

NLSY79  The NLSY79 is an annual (and later, biannual) survey of individuals aged 14–19 in 1979. We limit the sample to consist of civilian citizens which reduces the original sample of 12,686 individuals to the final sample size of 6,111 individuals. We measure own highest completed grade at the latest available year and the father’s highest completed grade as

\(^{13}\)For further documentation, see www.nlsinfo.org.

\(^{14}\)For further documentation, see http://www.bls.gov/cps/cps_over.htm#faq and http://www.census.gov/cps/data/.
reported by the respondents. Educational categories are defined in the same way as the Danish longitudinal sample (see below): *Less than high school* - less than 12 years of schooling, *High school graduates* - 12–14.9 years of schooling, *College graduates* - 15 + years of schooling.

**CNLSY** The CNLSY is a longitudinal survey of children whose mothers took part in the original National Longitudinal Survey of Youth in 1979. For the early years, the surveys were annual and for the later years the surveys were biannual (as part of the NLSY79). For the early childhood years, information is provided solely from the mother/parents/caretaker (except some test scores/ratings of the child), while during adolescence, the youth also provide much of the survey information. Of the 11,504 children included in the CNLSY data, we restrict the data to only include children of the representative NLSY79 sample.

We use the Peabody Individual Achievement Test (PIAT) scores to measure cognitive skills. The CNLSY features three sets of PIAT scores; reading recognition, reading comprehension, and math. For non-cognitive skills we use the antisocial, headstrong, hyperactivity subscales from the Behavior Problem Index (BPI). The measures of cognitive skills and non-cognitive skills are in accordance with those of Heckman et al. (2006) and Cunha and Heckman (2008).

We define both high school completion and college attendance as dummy variables. High school completion is determined using the questions on whether the child (youth) has a high school diploma/GED or not.\(^\text{15}\) We define college attendance as a report of either full- or part-time enrollment in college. As we use information on educational attainment up until age 21, we restrict the sample to cohorts born in 1990 or earlier. In addition to information on own characteristics, we include information on the mother’s characteristics and household income measured at age 15 from the original NLSY data. We use the sum of the mother’s and her spouse’s reported wage income\(^\text{16}\) and assets to measure household income and wealth, respectively. We measure wealth when the child was 15 years old and income as the average

\(^{15}\)Cameron and Heckman (1993), Heckman and Rubinstein (2001), and Cunha and Heckman (2008) show that these two concepts are not equivalent. However, omitting GED from the definition of high school completion would likely reduce the similarities of Denmark and the U.S., as the Danish measure of high school completion also includes a variation of the GED (HF).

\(^{16}\)Results are robust to using gross income, including UI and welfare transfers.
income between the child’s 3rd and 15th year. We restrict the sample to individuals for whom we observe at least one test score for both cognitive and non-cognitive skills, along with parental income. The CNLSY contain information on birth characteristics for all children, while some of the test scores and questionnaires are missing or not reported. This leaves us with a sample of 3,268 individuals.

**NLSY97** The NLSY97 is an annual (and later, biannual) survey of individuals aged 14–19 in 1997. The full survey sample consists of 8,984 individuals. We limit the sample to consist of the cross-sectional civilian citizens to arrive at the final sample size of 6,746 individuals. We measure own highest completed grade at the latest available year and father’s highest completed grade as reported by the respondents. Educational categories are defined in the same way as the Danish longitudinal sample (see below): *Less than high school* - less than 12 years of schooling, *High school graduates* - 12–14.9 years of schooling, *College graduates* - 15 + years of schooling.

**PSID** The Panel Study of Income Dynamics (PSID) is a longitudinal survey (annual until 1998, biannual from 1999) from the U.S. The survey was first conducted in 1968 with a representative sample of more than 18,000 individuals (in 5,000 families). The survey also follows children from the original families, which have now grown into adulthood.

In our analysis in Section 2, we use only the Survey Research Center component of the sample and exclude the Survey of Economic Opportunity component. The extract used include childrens born between 1972 and 1978, yielding a sample of 621 parent-child matches.

We use more years to measure average income in the U.S. than in Denmark (see below), in order to obviate the problem that many in PSID have no-reports in some years. If we for example only used three years as we do for the child-generation in Denmark, many observations would be based on only one measure of income. This is not a problem in the Danish register data.
CPS  In order to construct long-run trajectories of income by educational level, we use the March Current Population Survey (CPS, 1968–2014) from Integrated Public Use Microdata Series (IPUMS). The sample consists of civilian, non-institutionalized citizens. We use parents in 1987 and individuals aged 36–38 in 2011 (Section 2.2), and individuals aged 33–34 and 53–54 in each wave from 1980–2014 (Section B), where we obtain samples consisting of 116,604 individuals from the 1927–1958 cohorts and 169,860 individuals from the 1947–1978 cohorts. We measure the income for the former group at ages 53–54 and for the latter group at ages 33–34.

Wage is measured as sum of wage and salary income, non-farm self-employment income, and farm self-employment income. Wage+UI/Welf is measured as sum of Wage measure, income from unemployment benefits and welfare income, which includes Social Security Income, Supplemental Security Income (SSI), and other public assistance income. Wage and Wage+UI/Welf is all reported income excluding negative business and farm income. Wage and Salary income was adjusted for top coding following procedure in Autor et al. (2008). All calculations are weighted by CPS sampling weights and are deflated using the PCE deflator. Educational categories are defined in the same way as the Danish longitudinal sample (see below): Less than high school - less than 12 years of schooling, High school graduates - 12–14.9 years of schooling, College graduates - 15 + years of schooling.

We use the March Current Population Survey (CPS, 1981–2011) to construct occupational categories. The sample consists of civilian, non-institutionalized citizens with less than a college degree at age 26 in each wave. Number of observations used to create the chart is 53,705. Employment is defined as being at work or being absent from work but having a job during the time preceding the interview week. Again, educational categories are defined as: Less than high school - less than 12 years of schooling, High school graduates - 12–14.9 years of schooling. Occupational Categories are defined in the following way: “Care” - occupations related to health care assistance, nursing, child care, and teaching; “Sales/Services” - occupation related to sales and services except for “Care” occupations.
defined above; “Office” - occupations related to office work; “Manual” - occupation related to physical work done by people in production, operation, assembly, transportation, agriculture, forestry, fishing, crafts and related areas.

**F.2 Danish Data**

For all information for Denmark we use administrative register data. All of the main data sources from the Danish administrative register data recorded by Statistics Denmark contain a unique individual identifier which allows us to link information on demographic characteristics, educational attainment, income, and welfare benefits for the entire Danish population at any given time between 1980 and 2013.\(^1\) The data also includes parents’ unique individual identifiers. Using these, we link the information of the children to parents’ income, demographic characteristics, and educational attainment.

**Cohorts of 1973–1975** For the analysis in Section 2, we use all children born in Denmark. We choose to use the cohorts of 1973–1975 do not use 1972–1978 cohorts (as in the PSID for the U.S., see above) as main specification for Denmark because the Danish register data starts in 1980 which will imply that we miss the first year for parents to children born in 1972 and because the last years of income would be measured at an too early age for the 1976–1978 children.

We discard individuals who migrate or whose parents migrate, and individuals for which we have no identification of their father and mother (each around 3% of the sample). Danish income data is based on tax-records. Some types of income (for example business profits and tax payments) may be shifted between tax-years to smooth income or as a result of tax avoidance. Likewise, as a result of shifting of income and tax-payments, a non-trivial share of individuals have negative incomes within a given year. However, as we base our income measures on averages across several years, these year-to-year fluctuations will be offset and

\(^{17}\)For general information on Danish register data in English, the reader is referred to: [http://www.dst.dk/en](http://www.dst.dk/en).
we only have a remaining miniscule number of individuals with negative incomes over several years—we discard these individuals from the analysis. The final sample size is 166,359, of which 149,190 child-parent matches have positive incomes throughout the years we measure income.

1987 Cohort as Panel  We use the entire cohort of children born in Denmark in 1987. Using a unique individual identifier, we link schooling outcomes in the educational register to exam grades from the grade registers. We measure skills using grades from the 9th grade (the final year of compulsory schooling) and discard all children who have not completed compulsory schooling because they attend special needs schooling. We measure cognitive skills\(^{18}\) using final math exam grades (written), math midterm grades (written), final physics exam grades and non-cognitive skills using organization/neatness grades\(^{19}\) from the Danish written exam, Danish written midterm, and math written exam. We define high school completion as having completed an education that requires at least 12 years of schooling, and college as having been enrolled into an education that requires at least 15 years of schooling.\(^{20}\) Figure A52 illustrates how the two schooling outcomes are affected by our definitions.

Using the parental unique identifier, we link the information of the children to parents’ income and wealth, demographic characteristics, and mother’s educational attainment. We use parents’ annual wage income to construct the measure of household income and assets at the end of the year to construct the measure of household wealth. We measure parents’

\(^{18}\)As test scores of grades are highly associated with non-cognitive skills (Borghans et al., 2011a,b), we use residuals from the cognitive measures regressed on the non-cognitive measures in the measurement system.

\(^{19}\)One concern is that our measures of non-cognitive skills are closer related to academic achievement than to socio-emotional skills. We do not consider this to be an issue in the present case. When we estimate factor loadings and perform variance decompositions from the two factors on outcomes, DUI and psychiatric admissions, these outcomes are significantly more associated with non-cognitive (socio-emotional) skills than cognitive skills. The factor for non-cognitive skills explains around three and five times as much of the variance in DUI and mental disorders compared to the factor for cognitive skills.

\(^{20}\)The Danish educational system is rooted in a Northern European tradition and is not directly comparable to the U.S. system, while secondary and tertiary educations in Denmark are highly comparable to those in countries as Germany and Norway. Our definition of ‘high school’ and ‘college’ brings the U.S. and Danish system closer, both qualitatively and in population means. However, this simplification of the Danish educational ladder reduces comparability to other Scandinavian schooling systems, unless similar simplifications are made there as well.
wealth in 2002 (at age 15) and income as average wage income between the child’s 3rd and 15th year. We define high school completion as more than 12 years of completed schooling until age 22 and college attendance until age 25, because college enrollment is usually a few years later in Denmark compared with the U.S.. We restrict the sample to children whose parents have non-negative household wage income in 2002. This results in a sample of 39,539 children.

We use grades to estimate ages 15–16 cognitive and non-cognitive skills for the 1987 cohort and the DALSC sample. Table A18 summarizes the Danish grading system. When we estimate skills, we keep the relative distance between each of the individual grades in the Danish system.

**Table A18: Summary of Danish grading**

<table>
<thead>
<tr>
<th>Grade in Denmark</th>
<th>Content</th>
<th>ECTS Grade</th>
<th>U.S. Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>Excellent in all aspects</td>
<td>A</td>
<td>A+ or A</td>
</tr>
<tr>
<td>10</td>
<td>Very good, only minor weaknesses</td>
<td>B</td>
<td>A- or B+</td>
</tr>
<tr>
<td>7</td>
<td>Good, some weaknesses</td>
<td>C</td>
<td>B</td>
</tr>
<tr>
<td>4</td>
<td>Fair, some major weaknesses</td>
<td>D</td>
<td>B- or C+</td>
</tr>
<tr>
<td>02</td>
<td>Adequate, minimum acceptance level</td>
<td>E</td>
<td>C</td>
</tr>
<tr>
<td>00</td>
<td>Fail, inadequate</td>
<td>Fx</td>
<td>D</td>
</tr>
<tr>
<td>-3</td>
<td>Fail, unacceptable in all aspects</td>
<td>F</td>
<td>F</td>
</tr>
</tbody>
</table>

Figure A52: Impact of schooling definitions of rates of high school completion and college attendance, Denmark

(a) High school completion, by highest grade completed and age

(b) College attendance, by cohort and age

Note: Figures show rates of high school completion and college attendance by various definitions in Denmark. Both figures are constructed using administrative register data. Figure A is constructed using the 1987 sample (based on the full cohort) used throughout the paper. It shows potential rates of high school definition across age and highest grade completed. Figure B is constructed using register data for the full cohorts born in 1981, 1983, 1985, and 1987, and the 1987 sample used throughout the paper. It shows rates of college attendance by the definition used in the paper across age and cohorts.
### F.3 Summary Statistics

**Table A19: Summary of sample selection**

<table>
<thead>
<tr>
<th>Sample selection</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>U.S.: CNLSY</strong></td>
<td></td>
</tr>
<tr>
<td>Original CNLSY sample</td>
<td>11,504</td>
</tr>
<tr>
<td>From representative sample</td>
<td>5,422</td>
</tr>
<tr>
<td>Born 1990 or earlier</td>
<td>4,023</td>
</tr>
<tr>
<td>With test scores information</td>
<td>3,268</td>
</tr>
<tr>
<td><strong>U.S.: PSID</strong></td>
<td></td>
</tr>
<tr>
<td>All children born 1972–1978</td>
<td>1,257</td>
</tr>
<tr>
<td>Children born 1972–1978 in the Survey Research Center component</td>
<td>860</td>
</tr>
<tr>
<td>Income reported from age 30 or above</td>
<td>702</td>
</tr>
<tr>
<td>With positive incomes</td>
<td>621</td>
</tr>
<tr>
<td><strong>Denmark: Cohort 1987</strong></td>
<td></td>
</tr>
<tr>
<td>Born in Denmark in 1987, and in Denmark and with educational information 2006–2012</td>
<td>52,915</td>
</tr>
<tr>
<td>Parental information throughout childhood</td>
<td>49,945</td>
</tr>
<tr>
<td>Skipped grade or early school start (exam before 2002)</td>
<td>48,323</td>
</tr>
<tr>
<td>With test score information 2002 (attended exam and not in special needs school)</td>
<td>39,539</td>
</tr>
<tr>
<td><strong>Denmark: Cohorts 1973–1975</strong></td>
<td></td>
</tr>
<tr>
<td>Born in Denmark 1973–1975 and with residential information/present in Denmark, age 10</td>
<td>205,613</td>
</tr>
<tr>
<td>In Denmark and with income information 2010–2012</td>
<td>195,270</td>
</tr>
<tr>
<td>With ID of both parents</td>
<td>175,780</td>
</tr>
<tr>
<td>With non-negative incomes and parents not emigrated/died before child age 15</td>
<td>166,359</td>
</tr>
<tr>
<td>With positive incomes</td>
<td>149,190</td>
</tr>
</tbody>
</table>

*Note:* Table shows main sample selection criterions and corresponding sample sizes for our main data sources that we use. U.S. data: CNLSY and PSID; Danish data: Register data of cohort of 1987 and cohorts of 1973–1975.
Table A20: Summary statistics of covariates

<table>
<thead>
<tr>
<th></th>
<th>CNLSY, U.S. 1987</th>
<th>Danish Cohort 1987</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (boy=1)</td>
<td>0.52</td>
<td>0.51</td>
</tr>
<tr>
<td></td>
<td>(0.50)</td>
<td>(0.50)</td>
</tr>
<tr>
<td>Minority/immigrant</td>
<td>0.16</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>(0.37)</td>
<td>(0.20)</td>
</tr>
<tr>
<td>Siblings</td>
<td>1.53</td>
<td>1.78</td>
</tr>
<tr>
<td></td>
<td>(1.17)</td>
<td>(0.90)</td>
</tr>
<tr>
<td>Mother’s age at birth</td>
<td>23.58</td>
<td>27.93</td>
</tr>
<tr>
<td></td>
<td>(4.21)</td>
<td>(4.68)</td>
</tr>
<tr>
<td>Mother high school</td>
<td>0.92</td>
<td>0.65</td>
</tr>
<tr>
<td></td>
<td>(0.26)</td>
<td>(0.47)</td>
</tr>
<tr>
<td>Mother college</td>
<td>0.33</td>
<td>0.38</td>
</tr>
<tr>
<td></td>
<td>(0.47)</td>
<td>(0.49)</td>
</tr>
<tr>
<td>Observations</td>
<td>3,268</td>
<td>39,539</td>
</tr>
</tbody>
</table>
Table A21: Summary statistics of skill measures and outcomes

<table>
<thead>
<tr>
<th>CNLSY, U.S. 1987, Danish Cohort</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Educational outcomes</strong></td>
</tr>
<tr>
<td>High school</td>
</tr>
<tr>
<td>College</td>
</tr>
<tr>
<td><strong>Cognitive skills</strong></td>
</tr>
<tr>
<td>Measure 1</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Measure 2</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Measure 3</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Non-cognitive skills</strong></td>
</tr>
<tr>
<td>Measure 1</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Measure 2</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Measure 3</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Observations</strong></td>
</tr>
</tbody>
</table>

*Note:* All skill measures are redefined to increase in skill levels.
# Table A22: Overview of data sets used for analysis in section 3.3 for Denmark and the U.S.

<table>
<thead>
<tr>
<th>Conditioning set</th>
<th>Content of measure</th>
<th>Source</th>
<th>Denmark</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Non-cognitive skills</strong></td>
<td>Behavioral Problem Index</td>
<td>Questionnaire ratings reported by mother, CNLSY survey data</td>
<td>Scores tanking behavior and orderliness of work and conduct during academic year, effort made in neatness of final essay and math test</td>
<td></td>
</tr>
<tr>
<td><strong>Cognitive skills</strong></td>
<td>Peabody Individual Achievement Test, reading recognition, math, reading recognition, reading comprehension</td>
<td>Test scores, CNLSY survey data</td>
<td>Exam grades, calculus, math/algebra, physics; residualized from non-cognitive scores</td>
<td></td>
</tr>
<tr>
<td><strong>Family background</strong></td>
<td>Child gender, immigrant/minority, urban region, mother’s age at birth, siblings, mother’s age at birth, mother’s years of schooling</td>
<td>CNLSY survey data</td>
<td>Child gender, immigrant/minority, urban region, mother’s age at birth, siblings, mother’s age at birth, mother’s years of schooling</td>
<td></td>
</tr>
<tr>
<td><strong>School background</strong></td>
<td>School and peer characteristics</td>
<td>Mother’s and child’s ratings, CNLSY survey data</td>
<td>Means of previous school cohorts’ characteristics</td>
<td></td>
</tr>
</tbody>
</table>

*Note: Table outlines the information and sources used as condition sets in Tables 4 and A16. The data sources, the construction of the data, and the variables are described and summarized in Section F (summary in Tables A20 and A21 in the Web Appendix).*
### Table A23: Summary of income definitions

<table>
<thead>
<tr>
<th>Income measure</th>
<th>Denmark</th>
<th>U.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Total gross income incl. public transfers</td>
<td>All taxable income including wage income, public transfers, profits from own business, capital income, foreign income</td>
<td>All taxable income including wage income, public transfers, profits from own business, capital income, foreign income</td>
</tr>
<tr>
<td>2 Total gross income excl. public transfers</td>
<td>Taxable income including wage income, profits from own business, capital income, foreign income excluding all public transfers (both taxable and non-taxable)</td>
<td>Taxable income including wage income, profits from own business, capital income, foreign income excluding public transfers paid to individual such as welfare public assistance, social security, disability, unemployment compensation, education support</td>
</tr>
<tr>
<td>3 Net-of-tax total income incl. public transfers</td>
<td>All taxable income including wage income, public transfers, profits from own business, capital income, foreign income minus all final income taxes paid in given year</td>
<td>Total gross (pre-tax) income from taxable sources minus individual retirement plan contributions, alimony paid, medical savings accounts, non-reimbursed employee business expenses, property taxes paid by the household during the previous calendar year, the federal retirement payroll deduction of an individual filing federal income taxes, and federal income tax liability, state income tax liability, and Social Security retirement payroll deductions for an individual or for a couple filing a joint tax return plus Earned Income Tax Credit for an individual or couple filing a federal income tax return</td>
</tr>
<tr>
<td>4 Wage earnings</td>
<td>Taxable wage income and fringes, and non-taxable income, severance pay, and stock-options plus taxable and non-taxable</td>
<td>Wage income and pre-tax income from self employment (business/farm)</td>
</tr>
<tr>
<td>5 Wage earnings plus transfers</td>
<td>4 plus social assistance, unemployment benefits, labor market leave, sick leave assistance, labor market activation, child-benefits, education grants, housing support, early retirement pension, disability pension, and retirement pension.</td>
<td>4 plus public transfers paid to individual such as welfare public assistance, social security, disability, unemployment compensation, education support</td>
</tr>
</tbody>
</table>

**Variables used for Denmark (see www.dst.dk for further information):**
1. Total gross income incl. public transfers = perindkialt
2. Total gross income excl. public transfers = perindkialt-overforsindk
3. Net-of-tax total gross income = perindkialt-skattotny
4. Wage earnings = loenmv
5. Transfers = overforsindk

**Variables used for Denmark (see www.dst.dk for further information):**
1. Total gross income incl. public transfers = INCTOT
2. Total gross income excl. public transfers = INCTOT-(INCSS+INCWELFR+INCGOV+INCSSI+INCUMENP+INCEDUC+INCVET +INCSURV+INCRETIR+INCWKCOM)
3. Net-of-tax total gross income = adjginc-fedtax-statetax-ficas-fedretir+eitcred-proptax
4. Wage earnings = INCWAGE+INCBUS+INCFARM+INCWKCOM
5. Transfers = INCSS+INCWELFR+INCGOV+INCSSI+INCUMENP+INCEDUC+INCVET +INCSURV+INCRETIR
References


*LABOUR 14*(3), 523–546.


